OL. XXIV. — No. 10. OCTOBER 1947

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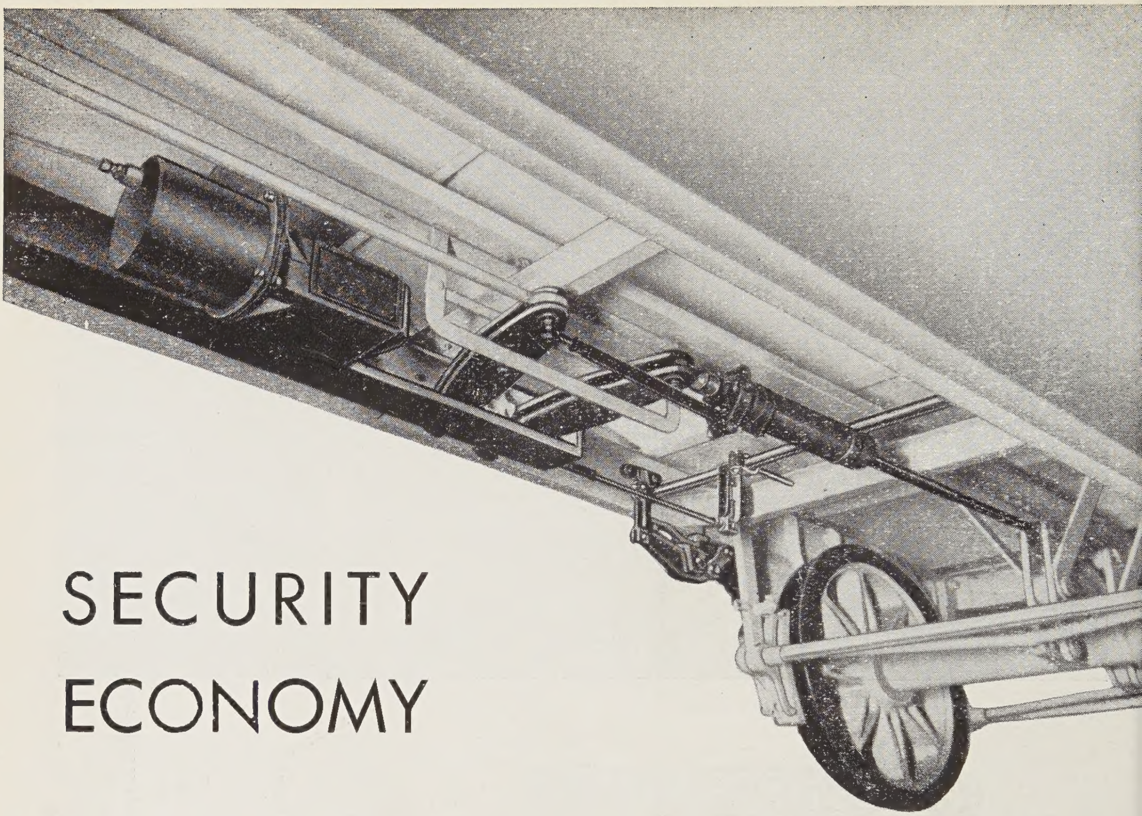
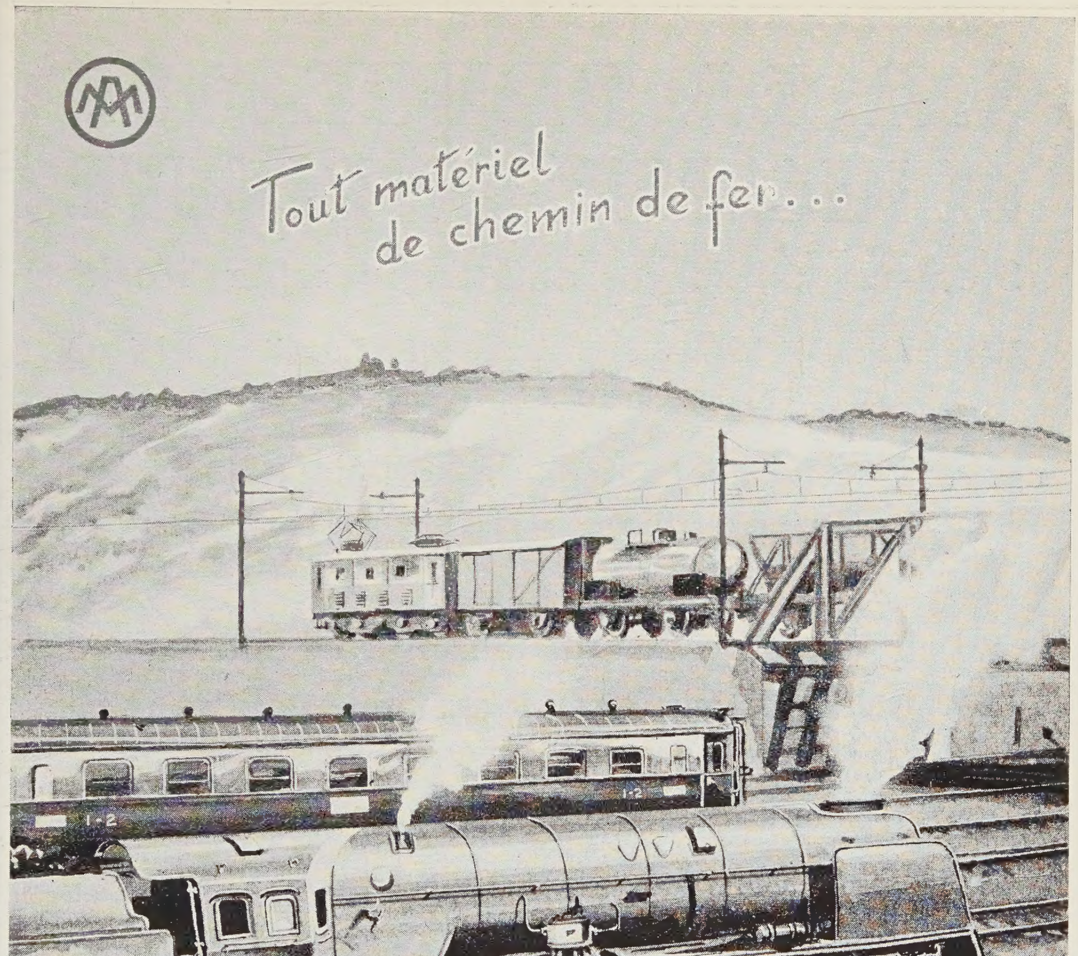
(English Edition)





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MONTHLY BULLETIN

OF THE

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VOL. XXIV. — No. 10. October 1947.

BULLETIN
OF THE
INTERNATIONAL RAILWAY CONGRESS
ASSOCIATION
(ENGLISH EDITION)

[621 .337]

Individual axle drive.

Mechanical systems used on electric locomotives and railcars, with an indication of the results obtained in service on railways of all kinds,

(Continued)*

by ADOLPHE-M. HUG,

Consulting Engineer, of Thalwil, (Zurich) Switzerland.

Chapter III.

DRIVING ARRANGEMENTS WITH RODS AND JOINTS.

INTRODUCTION TO CHAPTER III.

Before commencing this Chapter, it seems desirable to say something about the somewhat divergent methods (at least superficially) which were dealt with mainly in Chapter IV of **Cde. indiv.**, « Flexible driving arrangements with raised or superelevated suspension of motors with their axes in a parallel direction with the axles », pp. 22-79, figs. 38 to 164. Driving arrangements with *motors having their axes perpendicular to the axle* (superelevated vertical-axis motors for locomotives, conical gears) (longitudinal-axis motors for tramways, set in the bogie frame with conical or worm gears) were dealt with in Chapter V of **Cde. indiv.**, pp. 78-98, figs. 165 to 197. No distinction will now be made between these and motors with axes parallel to the axle as there is no record of any recent or new use of the systems.

Tramway transmissions will be dealt with in Chapter VII.

In other words, Chapter IV and V of **Cde. indiv.** are replaced in the present article (which is complementary to the original one) by the Chapters III to VI.

Articulated rod driving systems, with any new developments will be considered in practically the same order as in **Cde. indiv.**, viz (**) :

A. *Buchli system,* used by Brown-Boveri since 1919, pp. 22-36, figs. 38 to 70, of **Cde. indiv.** (first uses, see figs. 146 [right side in the elevation] and 147, left-hand driving axles, also 149 [lower-right side]).

(*) See *Bulletin,* No. of September, 1947, p. 823.

(**) See final line of *Introduction* to present article, *Bulletin* of September, 1947, p. 824, Reference should be made to the work in question (Orell-Fussli, Zurich, 1933) to which the present article is complementary.

B. *Oerlikon I and II systems,* pp. 53-56 (figs. 113 to 119) and pp. 72-74 (figs. 150 to 153) respectively, of **Cde. indiv.**

C. *Skoda system,* pp. 56-60 (figs. 120 to 125) of **Cde. indiv.**

D. *Alsatian system* (Als-Thom), page 74 (figs. 154 to 156) of **Cde. indiv.** (see also under G).

E. *Vertical axis motors* and conical gear arrangements of the « Constructions Electriques de France » (Midi and South-West regions of the SNCF) and Siemens-Schuckert, Austria (Austrian Federal Railways, BBOe).

F. *Isolated instances of arrangements,* Jeumont (pp. 69-70, fig. 146), Tschanz (pp. 70-72, figs. 146 to 149), Linke-Hoffmann-Bergmann (pp. 75-76, figs. 157 to 160). New York New Haven and Hartford RR., U.S.A. (pp. 76-77, figs. 161 to 162) and General Electric, U.S.A. (pp. 77-79, figs. 163 and 164).

G. *Other arrangements* introduced since 1932.

* * *

A. *Buchli system.* — This method of driving the axles, named after the inventor (22), comprises four different arrangements :

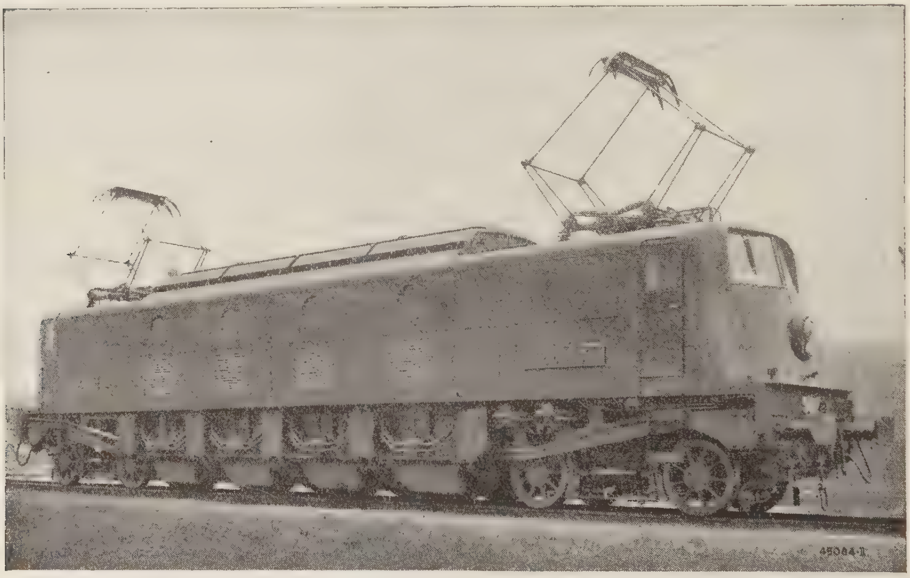


Fig. 13. — 2-D_0-2 locomotive No. 502 (1937), French Etat (SNCF-W), 1 500 V. D.C., 4 200 H.P. continuous rating. Max. speed 130 km./h. (80 m.p.h.), 125 tons. See figs. 50 and 51 of **Cde. indiv.**

a) unilateral outside control without hollow shaft, the most generally used type;

(22) J. BUCHLI†, Swiss Engineer, 1876-1945, Dr. ing. h.c., sometime Chief Engineer for locomotive construction at Brown-Boveri, and later President of the Administrative Council for Locomotive construction at Winterthur, S.L.M.

b) bilateral outside control, without hollow shaft;

c) unilateral inside control, with hollow shaft;

d) bilateral inside control, with hollow shaft.

The arrangements used up to 1931/2 are mentioned in **Cde. indiv.** as follows :

a) figs. 38 to 49, 58 to 61, 62-63 (twin motors to each axle), 69 and 70;

b) figs. 50 to 53;

c) figs. 64 and 65 (two twin motors to each axle);

d) figs. 54 to 57.

Amongst the various arrangements of this system introduced since 1932 may be mentioned :

Under a) :

Of the Swiss Railways (SBB-CFF-SFF), most extended use of the system, we will confine ourselves to noting the total number of standard locomotives of those series (type $2D_01$) of which the last were put into service in 1934 :

— type $2C_01$ (Ae 3/6), series 10601, 114 locomotives (Nos. 10601 to 10714) (figs. 40 to 42 of **Cde. indiv.**);

— type $2D_01$ (Ae 4/7), series 10901, 127 locomotives (Nos. 10901 to 11027) (figs 43 and 44 of **Cde. indiv.**).

This gives a total of 241 locomotives in the series, apart from the use of the system in individual special cases (see fig 70 of **Cde. indiv.**).

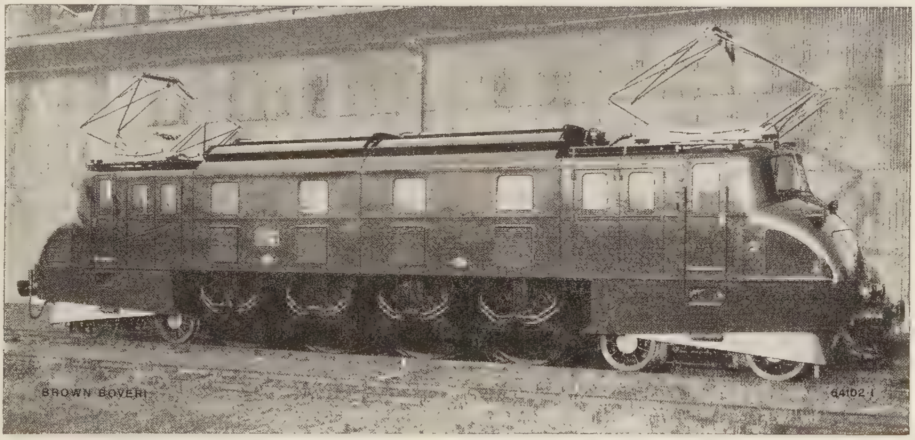


Fig. 14. — $2\text{-}D_0\text{-}2$ locomotive, E class, No. 528 (1937), French-P.-O.-Midi (SNCF, S.-W.). Same details as for fig. 13.

The $2C_01$ locomotives, originally built for a max. speed of 90 km./h. (56 m.p.h.) were converted for a speed of 100 km./h. (62 m.p.h.) and the $2D_01$ locomotives which were built for 100 km./h. now operate at 110 km./h. (68 m.p.h.) in normal service.

A proportion of the $2D_01$ locomotives (from No. 10973) are actually $2C_0\text{-}A1$, the rear carrying axle being combined with the neighbouring driving axle in one bogie with the pivot between the two

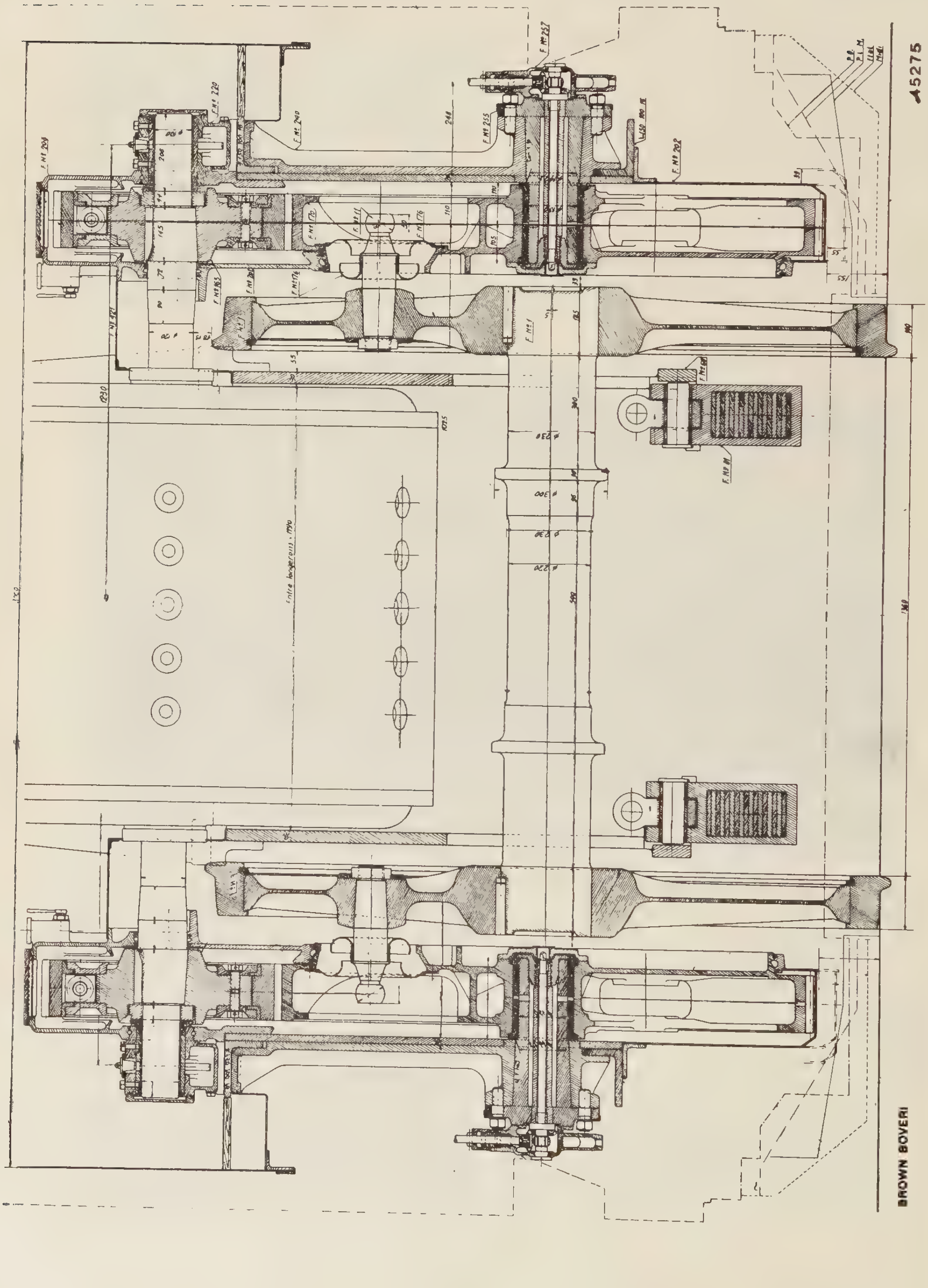
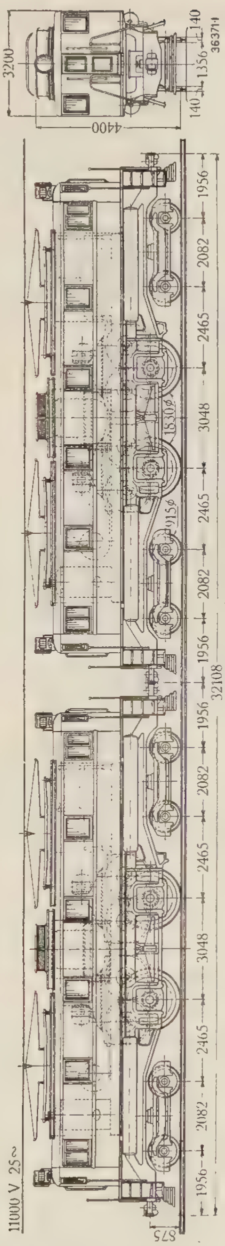


Fig. 15. — Cross-section of a driving axle of the locomotive shewn in figs. 13 and 14 (also fig. 52 of Cde. indiv.).



Brown-Boveri

Fig. 16. — Dimensioned sketch of two locomotives 7854/55, coupled as a multiple unit, of Pennsylvania R.R. (New York-Washington) (1930). 2 500 H.P. continuous rating. Max. speed 145 km./h. (90 m.p.h.). 2 × 134 tons, of which 2 × 66 tons is adhesive.

axles but near to the driving one, an arrangement which had moreover already been used for the special locomotive Ae8/14 No. 11801 already mentioned (fig. 70, **Cde. indiv.**).

A detailed consideration of this question will be made in Chapter V, on the subject of new locomotives, type $1D_01$ ($1A$-B_0-$A1$), Ae4/6, series 10801 of the St. Gothard line.

Of the E.16 series Reichsbahn locomotives, $1D_01$ type, 17 of which have already been reviewed in **Cde. indiv.** (p. 25, fig. 45) four more were put into service in 1932/3, making a total of 21.

As regards the 3001 series (type 1A-B_0-A1) of the Netherlands Indies State Railways, with « Java » type bogies, two similar new locomotives were put into service in 1928 for express working on the Batavia-Buitzenborg line (figs. 46 to 49 of **Cde. indiv.**).

These locomotives (also known as the 1A-AA-A1) with « Java » bogies, should, from the Author's experience, be noted as amongst the smoothest running locomotives both on curves and on the straight. (See the leading article of the Feb., 1947, issue of the *Revue Générale des Chemins de Fer* regarding the behaviour of these locos.)

Under b) :

On the S.W. and W. regions of the SNCF. operate a total of 73 locomotives, type 2-D_0-2, similar to those of 1925 described in pp. 26-27 (figs. 50 to 53) of **Cde. indiv.** Of these locomotives 28 were ordered by the Etat system (1937-1939, fig. 13), the others by the P.O.-Midi in 1933-1934 (fig. 14) ([23]). In regard to

([23]) See *Brown-Boveri Revue*, June, 1945, pp. 218-219.

these latter locomotives, fig. 15 also shews a vertical cross-section of one of the driving axles. The detailed arrangement is shewn and may be compared with fig. 52 of **Cde. indiv.**

Under c) :

All the locomotives under this heading have twin motors (two motors driving one axle) owing to restricted space between the two wheels on the axle, the space being occupied by the transmission, which is internal (see fig. 17).

Two locomotives, Nos. 7854 and 7855, type 2-B_0-2, class 01B, of the Pennsylvania Railroad (fig. 16) were quoted in **Cde. indiv.** (p. 31, fig. 65) and some additional details are given. Figs. 17 and 18 shew respectively a longitudinal and transverse cross-section of a driving axle and a view of the motor group and gears (drive enclosed).

These locomotives were put into service in 1931 and worked fast services on the four-track electric (single-phase, 11 kV., 25 cycles) line of 580 km. (360 miles) New York-Trenton-Philadelphia-Baltimore-Washington; they are operated in pairs with control by multiple units. They were built in the Altoona works of the Pennsylvania Railroad so far as the mechanical parts where concerned, whilst the transmission was supplied by Winterthur, Switzerland, and the electrical equipment by Brown-Boveri, of Baden. Maximum speed in service is 145 km./h. (90 miles p.h.), load on each driving axle 33 tons, tare of locomotives 134 tons, hourly rating 2 400 H.P. [24].

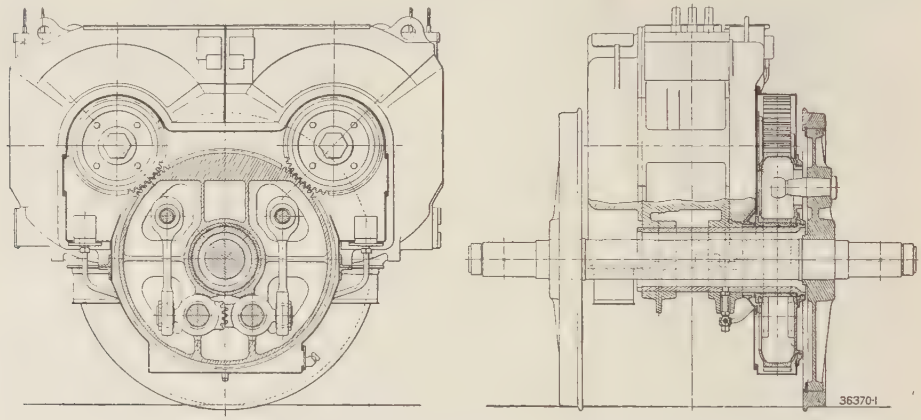


Fig. 17. — Driving axle with twin motors and driving mechanism, used on locomotive shewn in fig. 16 (longitudinal and cross sections).

With regard to the 1$D_0$1, 950 mm.

---

[24] See *Brown-Boveri Revue*, No. 3, May/June, 1933 (Pennsylvania RR.), pp. 91-94, 7 figs. (also *La Traction Electrique*, Oct. 1933, pp. 181-182). These two locomotives are the only two on the Pennsylvania RR. with drive other than the « rubber cup » (in place of the former « quill cup », see Chapter IV).

($3'1^3/_8''$) gauge, locomotive, series 301, of the Circumvesuviana Railways of Naples (SFSM) mentioned on page 31, under *g*), fig. 64, of **Cde. indiv.**, four more locomotives of the same type were put into service in 1933. Figure 19 shews one of these on the road at the San Giovanni depot.

Still *under c)* we may also mention a new use of the arrangement introduced since 1932; this consists of two *motor sets* in which the motor is set alongside the axle and is supported partly on the hollow shaft and partly on the bogie frame (fig. 20). It is, moreover, the only use of this arrangement for railcars. These two railcar sets, one double with four driving axles, the other triple with six driving axles, are those of the elT 1900 series of the Reichsbahn, put into service in 1936 and 1937 respectively; maximum speed in service 160 km./h. (99 m.p.h.) [25].

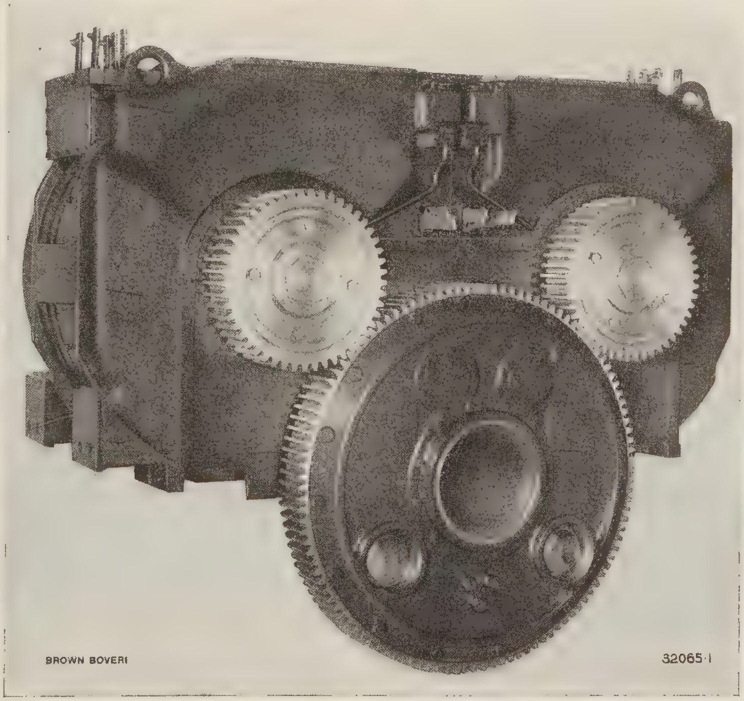


Fig. 18. — Motor group with gears and hollow shaft; locomotive in fig. 16 (see driving axle, fig. 17).

Under d) :

We have described (**Cde. indiv.**, pp. 27-29, figs. 54-57) the first twelve locomotives, type $2\text{-}C_0\text{—}C_0\text{-}2$, series 7201, put

[25] See *Elektrische Bahnen*, No. 11, 1938.

into service about 1930 on the express trains Irun-Alsasua (Paris-Madrid) of the Spanish Northern (Caminos de Hierro del Norte) — now part of the Spanish National Railways (Renfe), Northern Zone. Meantime, six locomotives of the same type were put into service in 1944 on the Madrid-Avila and Madrid-Segovia, bringing the total to 18.

Figure 21 shews one of these locomotives in service near Madrid.

It must however now be admitted — as has been rightly stated by Prof. K. SACHS of Baden, in his article « 25 Jahre Lokomotiv-Einzelachsantrieb Brown-Boveri-Buchli » (*SEV Bulletin*, No. 13 — Switzerland — 30/6/43, pp. 367-370) — that this Brown-Boveri-Buchli system has been superseded by more suitable arrangements; it has the drawback of a large number of joints and consequently of a large number of wearing points and it is difficult to seal off against the entry of foreign bodies, braking grit, etc. However, it was obviously popular at one time and there are nearly 350 locomotives in European and Overseas countries fitted with it.

Fig. 19. — Locomotive, series 0301, type 1-D_0-1, 1 000 H.P., for 950 mm. (3′1 3/8″) gauge, 1 200/2 400 volts D.C. line, Circumvesuviana (SFSM) of Naples. See fig. 64 of **Cde. indiv.**

There is nothing special to report regarding these uses of the arrangement and nothing to add to what has already been said.

Other Brown-Boveri arrangements — springs, discs — will be dealt with in Chapters IV, VI and VII.

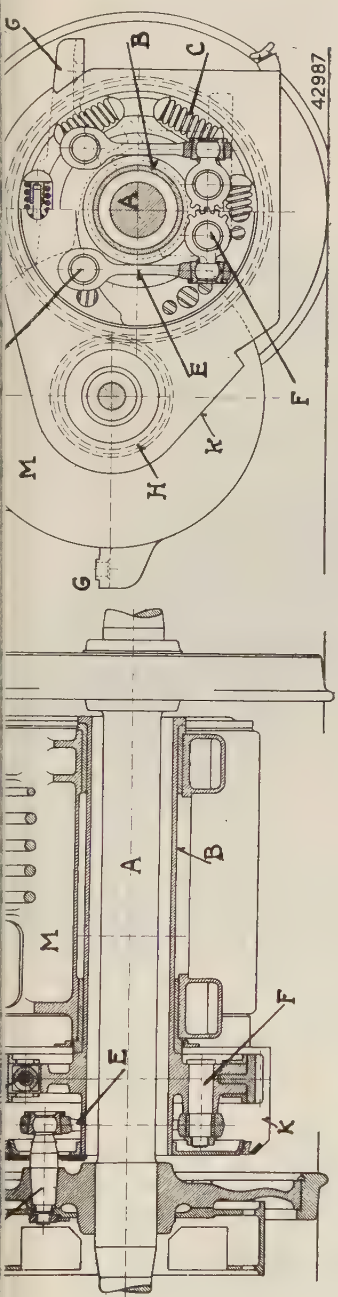


Fig. 20. — Driving axle of motor sets elT.1900 « Reichsbahn », 1935/7.

A : axle shaft.
B : hollow shaft.
C : springs of flexible rim.
D : wheel driving pin.
E : driving rods.
F : gear wheel driving pin.
G : motor suspension bracket.
H : pinion.
K : gear case.
M : traction motor.

B. *Oerlikon I and II arrangements.* — There has been no fresh use of the two and three types of gear described respectively in pp. 53-56 (figs. 113-119) and 72-74 (figs. 150-153) of **Cde. indiv.**, and there is nothing to add.

The use of Oerlikon II is still confined to the three driving axles of the 2-C_0-2 locomotive No. 4001 of the Great Indian Peninsula (GIP) Railway, now part of the Indian Government Railways (more recently the Indian State Railways).

New Oerlikon driving arrangements are dealt with in Chapter IV.

C. *Skoda arrangement.* — There have been now new uses of this arrangement apart from the five express locomotives, type $1A$-B_0-$A1$, group E.466, Nos. 001 to 005, put into service in 1926 by the Czechoslovakian State Railways (CSD). These locomotives also have a driving axle and a carrying axle in the same bogie frame (fig. 125 of **Cde. indiv.**).

D. *Alsatian arrangement.* — This was first used about 1930 on two driving axles of the 2-B_0+B_0-2, No. 242 AE 1 locomotive of the PLM (now SNCF, S.W. Region) and was described on page 74 (figs. 154-156) of **Cde. indiv.**; it was used and developed and then used in 1935 under the name Als-Thom on other locomotives (P.O.-Midi, S.W. Region, SNCF). It will be described in detail later, as there are certain interesting points in its application, differing from the original arrangement, although its principle remains the same.

D'. *Als-Thom arrangement.* — As already shew in Note (9), this arrangement was used on six locomotives, type 2-D_0-2

(26) of the Paris-Orleans system S.W. Region (P.O.-Midi) of the SNCF. These locomotives were numbered in the E.703 series, later 5302 to 5306. The re-numbering arose from the fact that E.703 (fig 22) was put into service in 1935 as an experimental locomotive (27), but the five later locomotives, put into service in 1941, were identical (28).

The main difference from what has previously been done is in the provision of a triple motor for each pair of driving axles and in that three units of one group operate three pinions driving two *coupled* gear wheels (polarised in pairs) by one intermediate gear wheel (26). Fig. 23 shews this device clearly and fig. 24 shews the triple motor having a single casting and a common housing for the three units of the group; the three equal pinions are shewn, and the three gears driven by them — the centre one being of somewhat smaller diameter than the two outside ones which are fitted to the hollow shafts of the driving axles. The coupling of the gear wheels involves on opposite direction of revolution for the central unit of each group

Photo Brown-Boveri.

Fig. 21. — Express locomotive, series 3501, type $2\text{-}C_0+C_0\text{-}2$ of the RN (Renfe, Spain, N. Zone). 3 200 H.P.. 110 km./h. (68 m.p.h.), D.C. 1 500 volts (see figs. 54 to 57, **Cde. indiv.**)

(26) As, in this type of machine, the triple motor operates two driving axles connected by an intermediate gear, there is no proper individual axle drive, but it is clear that differences of this kind may be conceived and developed from individual axle drive.

(27) Forming part of a batch of four trial locomotives ordered by the P.O. in 1935 from different constructors.

(28) See *Revue d'Electricité et de Mécanique* (published by the « Société Générale de Constructions Electriques et Mécaniques ALS-THOM », Nos. 46 (March-April, 1936), 50 (Nov./Dec., 1936) and 51 (Jan./Feb., 1937).

from that of the other two units — the distance between the axes of the outside units is therefore rather greater than the wheelbase of the two driving axles of the group.

are only single-sided and inside. Fig. 27 shews one of the Repusseau type silent-blocks set in the joints of each rod; the comparatively high degree of elasticity of these joints greatly reduces local stresses

Cliché Als-Thom.

Fig. 22. — Express locomotive for 150 km./h. (93 m.p.h.), No. E703, type 2-D_0-2, P.O.-Midi, (SNCF-S.W.), triple motors and paired driving axles, 1 350 volts D.C. Standard track.

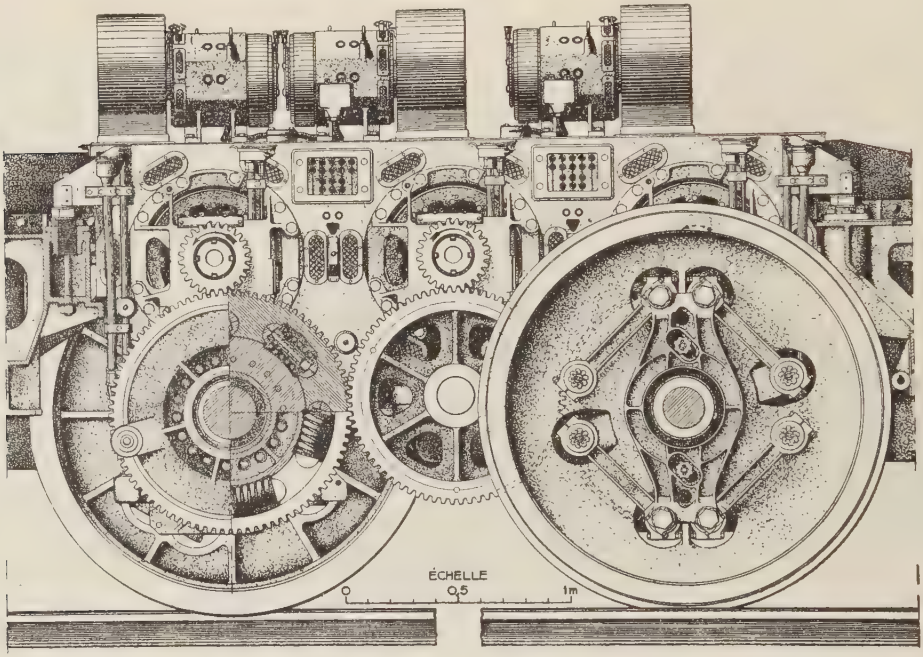
Fig. 25 shews the driving axle equipped with the complete mechanism and fig. 26 the hollow shaft with spring-loaded gear wheel. It is shewn, as in fig. 29, that the mechanism itself is bilateral (outside the axles on both sides), whilst the gears and — an important point — assures a suitable division of tractive effort between the two wheels on the axle.

These « silent-blocks » have in addition the effect of equalising stress when the axle is not parallel with the hollow shaft

(and therefore with the body of the locomotive) as a result of track inequality or movement of the body bearers [29].

Fig. 28 shews the intermediate gear wheel, itself rigid (without springs) mounted on the shaft and resting on the bottom block.

These locomotives have a total weight of about 140 tons, of which about 84 tons is the mechanical part (including flexible couplings and compressed air brake equipment without the compressor groups) and about 55 tons for the electrical parts — the remainder, about 1.5 tons, being made up of sand, fittings, etc. The load on the driving axles is 20 tons [30] — or 80 tons adhesive weight — and for the carrying axles 13.5 and 16.6 t. respectively for each bogie. The maximum permissible working speed is 150 km./h. (93 m.p.h.).



Cliché Als-Thom, 4907.

Fig. 23. — Set of a pair of driving axles, gear-coupled, and the triple motors. On the left, the outer wheel is omitted to shew the sprung gear wheel

As a result of trials, it would seem that the triple motor — or more accurately, the coupling by an intermediate gear wheel of the two principal gear wheels on the two driving axles of one group

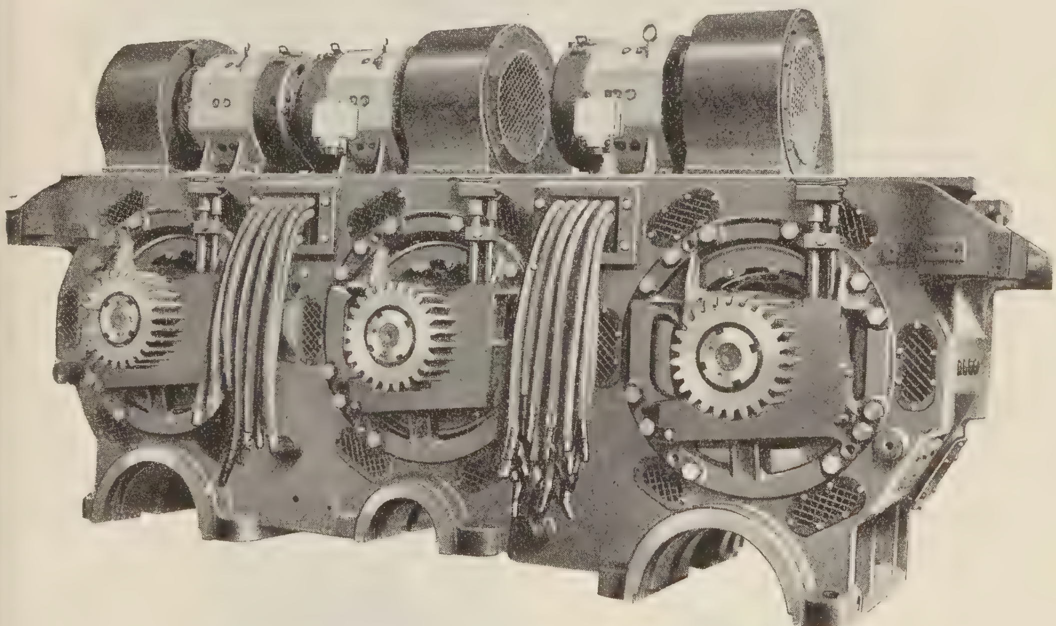
[29] None of these silent-blocks has proved defective so far. The Author has seen one cut horizontally through the middle after a mileage of 500 000 km. (310 686 miles) and it was still perfect.

[30] May be increased to 22 t. by ballast.

— reduces the possibility of slipping, particularly at high speeds, to a point equivalent to a higher adhesive weight, which may reach 130 % of the effective tractive effort. In other words, this locomotive works as if the adhesive weight were 100 tons.

Let us now describe the control mechanism itself. The transmission couple between the hollow shaft and the axle is effected by an arrangement comprising, for each wheel, a floating ring and four rods (figs. 23 and 25). Each wheel centre has two crankpins, diametrically opposed, which serve as joints for the coupling between the hollow shaft and the axle.

At each end of the floating ring are pivoted two rods. One connects a crankpin of the hollow shaft to the floating ring, the other connects one of the crankpins on the wheel centre to the same end of the floating ring. The pins on the hollow shaft pass through the wheel centre (figs. 23, 25 and 29). The two rods which connect, through the floating ring, the pin of the hollow shaft to the pin of the wheel centre are perpendicular to each other in the central position. which allows the necessary two directions of flexibility. The floating ring is stabilised under the effort exerted by the four rods.



Cliché Als-Thom.

Fig. 24. — Triple motor in single housing with three intakes, fitted to locomotive shewn in fig. 22 (see also fig. 23).

To facilitate assembly and dismantling the floating ring is, however, checked — although with considerable play — by

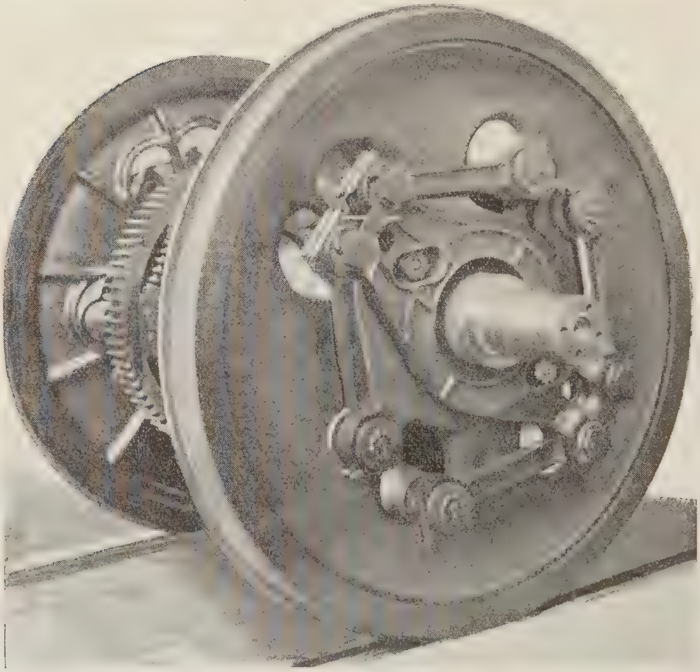


Fig. 25. — Driving axle with bilateral mechanism (single-sided gear). See figs. 22 and 23.

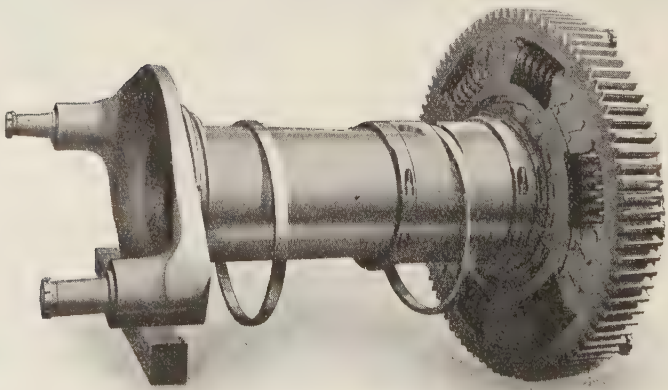


Fig. 26. — Hollow shaft with sprung gear wheel (part of assembly shewn in fig. 25).

two pins, solid with the wheel centre, which pass through two slots in the floating ring.

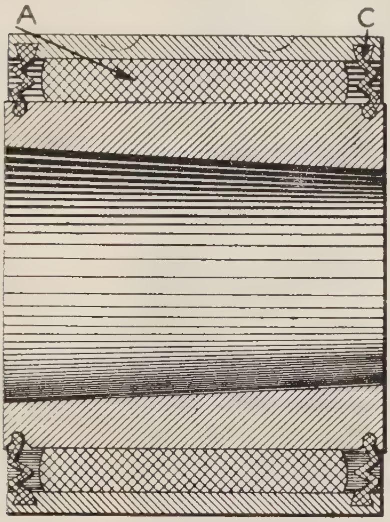


Fig. 27. — Section of a silent-bloc, Repusseau type, set in each rod joint (see figs. 25 and 29).

When the hollow shaft and the axle are not perfectly concentric — as a result of vertical movement of the axle in relation to the underframe — the momentary angular speed of the axle is not constantly equal to that of the hollow shaft but is subject to a small periodical variation, the period being one revolution of the wheel.

If the arrangement of rods and floating ring of the two wheels of one axle were set symmetrically in the longitudinal plane of the locomotive, these periodic variations would be phased and could give rise to oscillation in the transmission system and in the suspension and thus produce irregularities in the tractive effort on rail. For this reason the two arrangements are set symmetrically in relation to an axis perpendicular to the centre of the axle and in the plane of the crankpins on the wheels.

The periodical speed variations are thus set in opposing phases and for the whole of the axle assembly are obviously cancelled out.

With this system, an arrangement without play or flexibility would develop

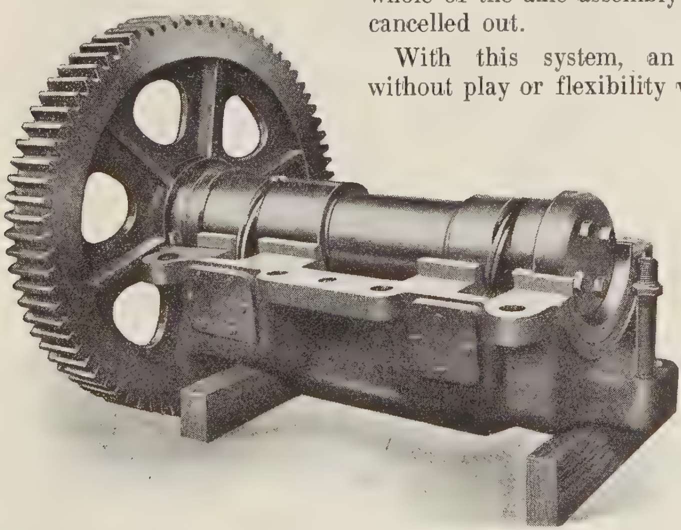
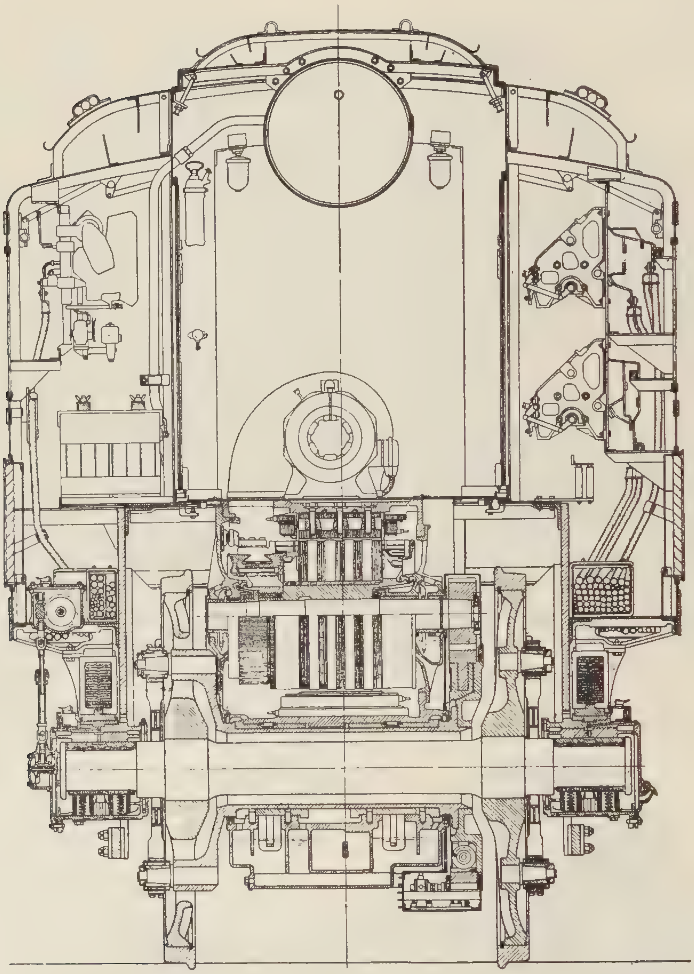


Fig. 28. — Intermediate gear wheel (two per locomotive) and shaft (see figs. 23 and 30).

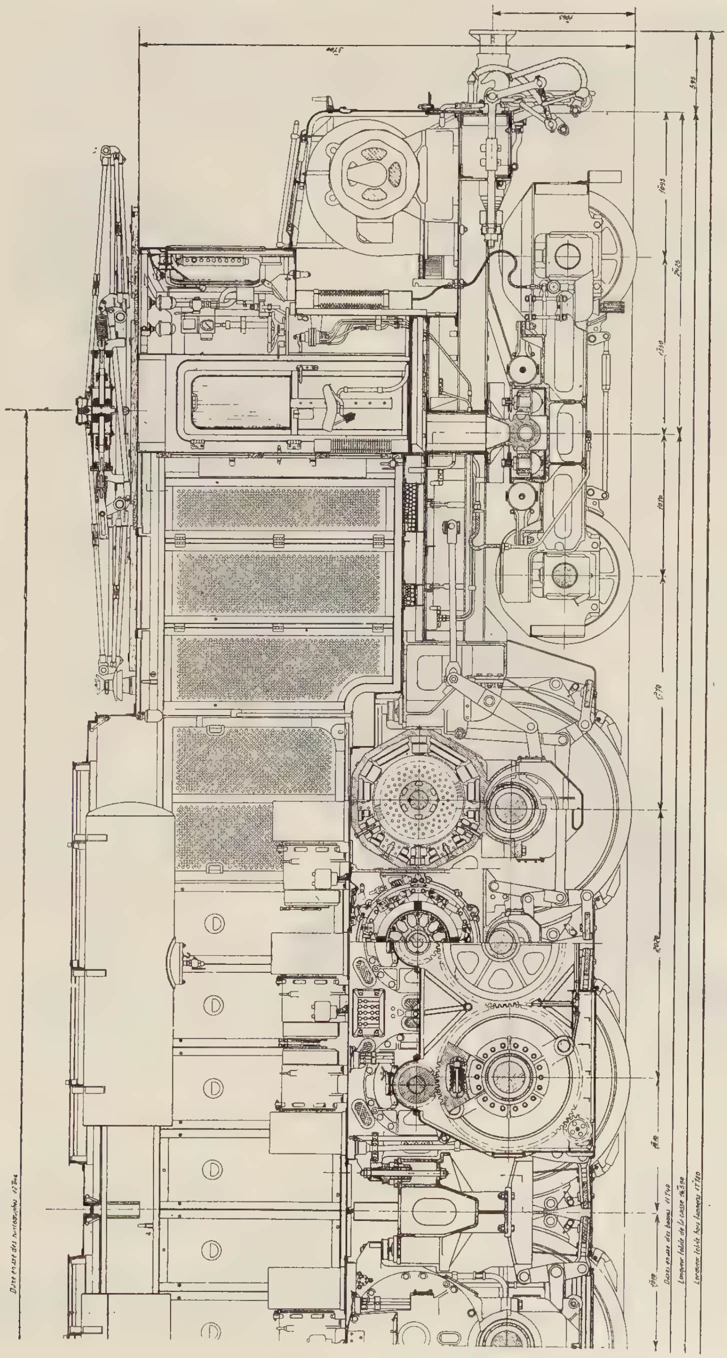


Plan Als-Thom.

Fig. 29. — Cross-section of locomotive shewn in fig. 22, through the leading driving axle (see figs. 25, 26 and 27).

in the rods, pull would develop in the axles and excessive torsion on the hollow shaft couple would result; for these reasons, the silent-blocks previously mentioned have been used.

The reduction ratio of the transmission is 87: 25 teeth, or 1 in 3.48; the intermediate wheel — whose blocks (fig. 28) do not transmit any couple but merely serve to engage the pinion of the central motor of a group with the gears of the pair of driving axle of this group — has 76 teeth. The teeth are set at right angles, with a modulus of 12.415 mm. (0.488788 inch.), pitch of 18° without diametrical correction. The



Plan Als-Thom.

Fig. 30. — Longitudinal section of $\frac{1}{2}$ locomotive shewn in fig. 22 (see figs. 23-26, 28 and 31).

pinions and gears are of treated Cr-Ni-Mo steel of 120 kgr./mm² (76 Engl. tons per sq. inch.) (105 [66.66 Engl. tons] for the flexible rims of the hollow shaft).

Returning to the general aspects of this locomotive, figs. 29 and 30 shew respectively the cross section through the leading driving axle and a central longitudinal section. As shewn in fig. 29 plan, the pivots of the hollow shaft rods are set at right angles to those of the axle rods. In other words, if the axle rod pivots are in a vertical axis (right-hand side of fig. 29) those of the hollow shaft are in a horizontal axis (left). The reasons for this are evident, and have been shewn in the description of the mechanism itself.

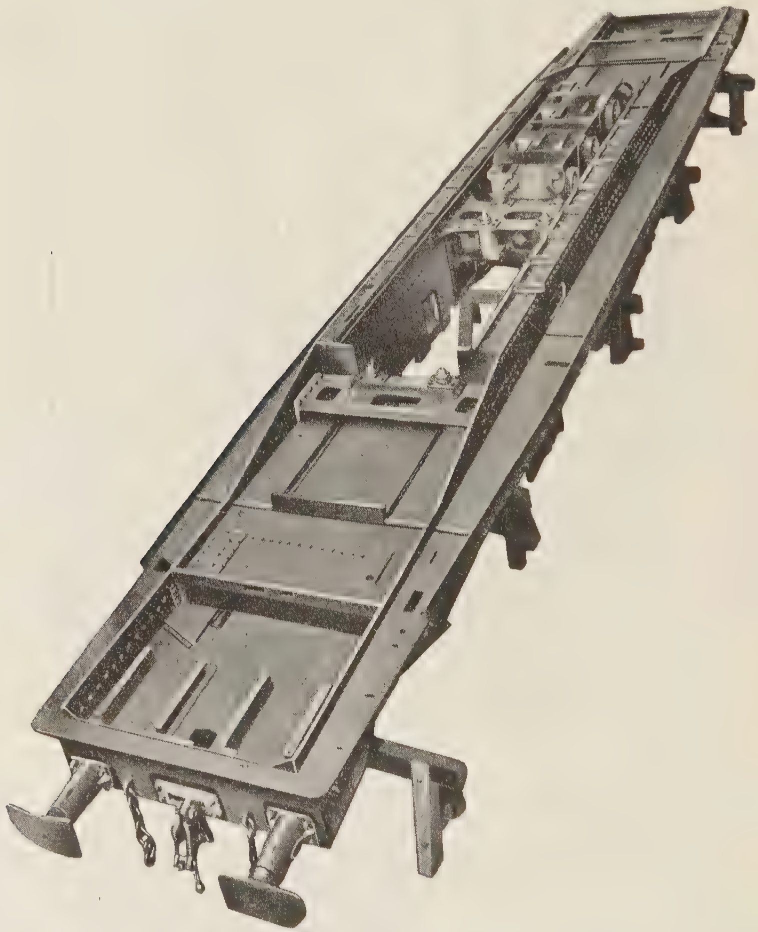


Fig. 31. — Underframe of the locomotive shewn in fig. 22. In the frame is mounted one of the triple motors.

Finally, fig. 31 shews the underframe of one of these locomotives with one of

the triple motor groups in position. Together, figs. 22 to 31 give a clear picture of the general arrangement and of the driving mechanism of the locomotive.

The mechanism has been quite satisfactory in service and has shewn low maintenance costs. The six locomotives on which it has been used have all exceeded 200 000 km. (124 274 miles) before general repairs.

E. *Arrangements with the axis of the motors vertical.* — As already stated in the Introduction to Chapter III, vertical motor axis arrangements for locomotives (figs. 165 to 176 for single motors, 177 to 184 for twin motors, **Cde. indiv.**) have not been used on any further locomotives and there is nothing new to add.

F. *Individual arrangements* (see F, Introduction to the Chapter).

Jeumont arrangement : nothing to add.

Tschanz arrangement : this has been used only on two of the driving axles of the experimental articulated three-part locomotive, $1B_01+1B_01$, No. 11300, of the CFF (Switzerland) (figs. 147-149, **Cde. indiv.**). It was not used on the $1B_02$ (fig. 146). There are no other examples of the arrangement.

Linke-Hoffmann-Bergmann arrangement : nothing to add.

Westinghouse arrangements with rods and floating ring, used by the NYNH & HRR. : Apart from its experimental use in 1927 on three driving axles of one of the bogies of the $1\text{-}C_01+1C_01$, No. 0303, the Pennsylvania RR. also fitted a P5A, type $2\text{-}C_0\text{-}2$ with this arrangement, but later dispensed with it, following the standardisation of the quill cup drive, replaced after 1939 by the rubber cup drive (see Chapter IV). Nothing is known of any further applications.

G.E.Co. arrangement with rods and pivots : This arrangement was used experimentally in 1930 on one or two locomotives of the Pennsylvania RR., class P.5 (?01), but was removed following the standardisation on rubber cup drive [see preceding paragraph, also note (24)].

G. *Other arrangements* with rods and joints : Apart from those already noted, nothing is known of any new arrangement used since 1932 (31).

(To be continued.)

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(31) In the number dated 2nd March 1945 of the *Electric Railway Traction (Railway Gazette,* London) mention is made on page 206 (fig. 4) of the use of an ASEA arrangement with rods and joints (« Etablissements ASEA », Västerås, Sweden) on the experimental locomotive No. 603, class F, type $1\text{-}D_0\text{-}1$ of the Swedish Railways (Statens Järnvägar, SJ.). This indication is erroneous, the ASEA arrangement in question has not been used.

[625 .14 (.73)]

Asphalt ballast, welded rails, good drainage

solve this station-track problem,

by John R. SCOFIELD,

Division Engineer New York Central System Chicago.

(*Railway Engineering and Maintenance, April, 1947.*)

The passenger mains at South Bend after the asphalt ballast had been installed.

Maintenance work required on the two main passenger tracks of the New York Central System through the station area at South Bend, Ind., has been substantially reduced as the result of a project that involved a combination of measures including the installation of asphalt-coated ballast, the laying of continuous butt-welded rails and the provision of a drainage system for disposing of surface water. This installation has now been in service for about 18 months, having been carried out in September, 1945, and the results obtained, in the form of reduced maintenance costs, have been highly satisfactory.

The problem presented by the excessive cost of track maintenance in station areas has been under careful consideration on the New York Central System for some time. It is recognized that economical track maintenance at such locations requires an efficient drainage system, but that proper drainage is difficult to maintain through station areas because of the peculiar conditions that

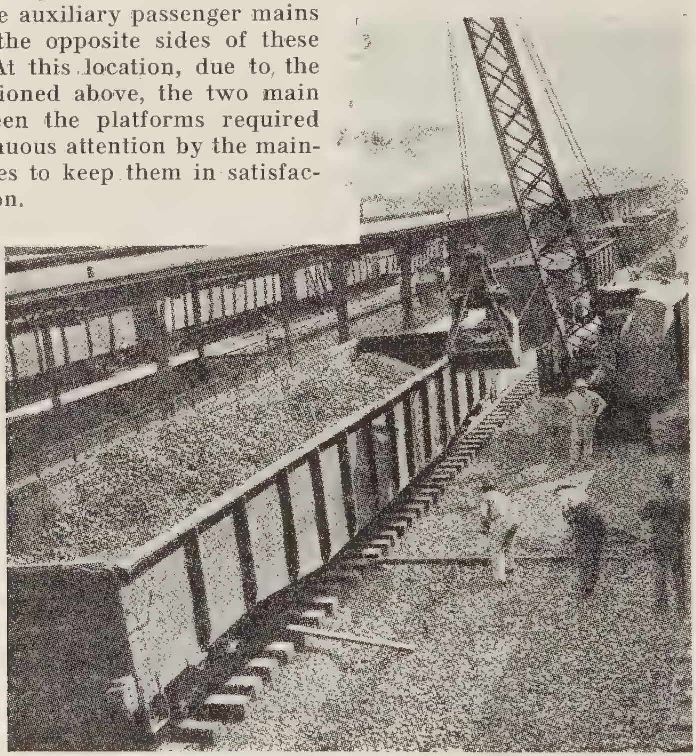
The plant where the ballast and emulsified asphalt were mixed.

Preparatory work on each of the station tracks included the excavation of the roadbed to a depth of 12 in. below the ties.

frequently prevail at such locations. Among these is the fact that the locomotive sand, which is applied in considerable amounts, tends to fill the ballast voids and thereby stops the seepage of water through the ballast. Also, the mixture of sand and stone ballast, in the presence of drippings from locomotives and cars, tends to cement itself into an impervious layer. Thus, with drainage blocked, a muddy condition develops which creates a difficult track-maintenance problem, especially at the joints, where mud, pumped up from the subgrade, was troublesome.

This was the situation that prevailed at South Bend before the corrective work was done. The layout through the

station area at this point embodies eight tracks, including two passenger mains, two auxiliary passenger tracks, three freight mains and a siding, all carried on a sand fill supported between concrete retaining walls. The two passenger mains are situated between two concrete island platforms, each 1 200 ft. long, with the auxiliary passenger mains lying along the opposite sides of these platforms. At this location, due to the factors mentioned above, the two main tracks between the platforms required almost continuous attention by the maintenance forces to keep them in satisfactory condition.



Unloading and spreading the first course of the asphalt-ballast mixture, which was 9½ in. depth.

Method already tested.

For a number of years the New York Central System has been giving careful consideration to the possibilities of correcting bad track conditions in station areas by using ballast coated with emulsified asphalt, the reasoning being that such ballast would be impervious to water and yet could be worked when necessary. As early as 1939 a test installation of such ballast was made in a 600-ft. length of the company's high-speed eastbound main track at Bryan, Ohio. The performance of this test section has been carefully observed by the railroad and by a subcommittee of the Committee on Roadway and Ballast of the American Railway Engineering Association, and the results of these observations have been recorded by the committee in its annual reports to the association. In a report that was made to the convention in 1943, the committee observed that « the track does not heave due to frost; the seal coat sheds water readily, retains foreign matter and prevents it from getting into the ballast. The track in the

test section rides well, remains in good line and surface and continues to give satisfactory results with a minimum of expenditure ».

Based on the results of the test at Bryan, it was decided to install asphalt-coated ballast in the two main passenger tracks at South Bend for the approximate lengths of the island platforms, employing such refinements as were indicated by experience with the Bryan test. As additional measures to reduce

New creosoted sawn ties were placed in both main passenger tracks throughout the station area.

stalling a length of butt-welded rail in one of the station tracks.

maintenance costs it was decided to eliminate practically all joints in the two tracks at the station by installing continuous butt-welded rails and to provide efficient surface drainage.

In preparation for doing the work an arrangement was made with a contractor to provide a one-cubic-yard Koehring paver for mixing the ballast and asphalt, the latter consisting of Texaco No. 23 emulsified asphalt. The paver was placed on an elevated dirt ramp so that, after being mixed, the asphalt-coated ballast could be discharged directly into gondola cars on an adjacent track. The mixing plant was located about five miles by rail from the site of the work, and the cars containing the mixture of asphalt and ballast were hauled several at a time to the station location by a switch engine.

To permit the work on the two main

passenger tracks to be carried out without interference from traffic, these tracks were taken out of service while the work was under way and all traffic normally carried by them was detoured over the two auxiliary passenger tracks on the opposite sides of the island platforms. Work on the westbound track was done first. After the old rails and ties had been removed from this track, the roadbed, which had become consolidated almost to the hardness of concrete, was excavated to a depth of about 12 in. below the bottoms of the ties, exposing the original sand-fill subgrade. The excavation work was accomplished with the aid of a crawler-mounted drag-line outfit, supplemented by a crawler bulldozer, the excavated material being loaded into gondola cars standing on the eastbound track. The subgrade was finished by hand, after which it was compacted to the required elevation by a 10-ton roller.

When the subgrade had been fully prepared the asphalt-ballast mixture was unloaded from cars standing on the eastbound track and spread over the subgrade to a depth of 9½ in. The unloading work was done with a crawler crane equipped with a clamshell bucket. The mixture for this part of the ballast section was made in batches of 32 cu. ft., each consisting of two parts of 2-in. stone and one part of ¾-in. graded stone, to which was added an average of 20

A seal coat about 2 in. thick was applied over the entire area between the platforms.

gal. of the asphalt emulsion. The crushed stone in the mixture consisted of a limestone that is regularly used on the New York Central System for ballast. Each car held an average of 40 batches, which comprised a volume sufficient to cover approximately 125 lin. ft. of the subgrade, 10 ft. 6 in. in width, to the 9½-in. depth.

Generally, the asphalt ballast was placed within two hours after being mixed. However, on several occasions it was necessary to hold cars of the material under load overnight. When this was done the cars were properly covered, and when they were unloaded the next day, 16 to 20 hrs. after the asphalt and ballast had been mixed, it was found that, except on the surface, there had been no evaporation of water from the asphalt.

As the asphalt-ballast mixture was unloaded it was carefully leveled. Following closely behind this work new creosoted sawed ties were placed in position on the first course of asphalt ballast. Next, the continuous lines of butt-welded rail, consisting of new 127-lb. rail, were placed in position on double-shoulder tie plates and fastened with four spikes for each tie plate, including two line spikes and two hold-down spikes. Each rail was made up of two continuous pieces 429 ft. long and one piece 351 ft. long, making a total length of 1 209 ft. Adjoining continuous lengths were joined after laying by conventional six-hole joint bars. Ample provision was made to keep the rails from creeping.

The butt-welds were made at the company's Beech Grove shops at Indianapolis, Ind., by the Oxweld pressure-welding method. After the welding work had been completed the continuous lengths were loaded into strings of open-end gondola cars for transportation to South Bend, a distance of about 170 miles. At the site the rails for the westbound track were unloaded onto the eastbound track and then maneuvered into final position by a Burro crane mounted on a car in a work train.

The placing of the ties followed immediately behind the unloading and spreading of the first course of asphalt ballast.

The eastward track.

After the westbound track had been rebuilt to the point described above, the

procedure was repeated with eastbound track, using the westbound for loading and unloading material. In the next step the cribs between the ties in both tracks were partially filled with a mixture of $\frac{3}{4}$-in. graded stone ballast and asphalt emulsion. Each 32-cu. ft. batch of this mixture contained 23 gal. of the emulsion. Each track was then surfaced on a one-inch lift, using pneumatic tampers, after which the cribs were filled to about one half their depth with the $\frac{3}{4}$-in. asphalt ballast.

Next, a seal coat about two inches thick was applied over the entire ballast area between the platforms, including the inter-track space. This coat was composed of a combination of 25 per cent sand and 75 per cent of $\frac{3}{4}$-in. stone screenings, thoroughly mixed with asphalt emulsion, and was graded to drain surface water to the inter-track space where a drainage system had previously been provided. A final step, taken to assure that no water would penetrate the surface, consisted of applying over the entire ballast surface a brush coat of a rich mix of sand and asphalt emulsion. When this had been completed, and before traffic was restored over the two tracks, the accumulation of emulsion drippings on the running surfaces of the rails was removed with kerosene and wire brushes, after which a coat of fine sand was deposited on the rails by a work-train engine to complete the cleaning and drying action.

The drainage system that was installed as part of this project embodies nine catch basins covered with metal gratings, six of which are located at intervals in the inter-track space. A system of outfall lines connects the catch basins with existing manholes at two street underpasses in the vicinity, which extend under the tracks approximately at the ends of the passenger platforms. To assure rapid run-off of water from the inter-track space, the tops of the catch basins were established at an elevation $16\frac{1}{2}$ in. below the tops of the ties, with the flow line rising in both directions from each catch basin to an elevation of 3 in. below the tops of the ties at the mid-points between catch basins. Thus the difference in elevation between the high points of the flow line in the inter-track space and the tops of the catch basins is $13\frac{1}{2}$ in.

Test section.

The question has been raised on the New York Central System as to whether a seal coat of asphalt ballast applied over untreated ballast would be effective in overcoming the track-maintenance difficulties ordinarily encountered with station tracks. To determine the answer to this question, short sections of the two main passenger tracks beyond the limits of the island platforms at South Bend were completely reconstructed as part of this project, using a bottom course of regular stone ballast, with no asphalt emulsion added. This untreated ballast was finished to a level two inches below that of the railroad's standard ballast section, after which a two-inch seal coat was applied, which was similar to the seal coat that was placed on the asphalt-ballasted section. The trackage treated in this manner extends a distance of about 220 ft. from each end of the asphalt-ballast section.

In October, 1946, more than a year after the asphalt-ballast track was installed at South Bend, repairs were made by tamping the track with pneumatic tampers at loose ties and elsewhere as necessary to bring low places back to the original grade. Inequalities in line were also corrected. Additional asphalt-coated screenings were applied where necessary after liquid asphalt had been applied around the ties for sealing purposes. A final seal coat of fine stone chips mixed with cut-back asphalt was then applied over the entire area between the station platforms. A cut-back asphalt was used for this seal coat be-

cause it was found to be more resistive to drippings from locomotives and cars than the asphalt emulsion. At the time these repairs were made a small test section was established involving a seal coat of roofing compound, the purpose being to determine the comparative effectiveness of this compound and the cut-back asphalt for the seal coat.

Little work required.

The combination of asphalt ballast, welded rail and good drainage have produced track that requires very little maintenance. In fact, the only attention that the asphalt track has required, other than that mentioned above, has been for one man occasionally to pick up debris and trash and to remove piles of sand left by locomotives. This man has also applied liquid asphalt to places where steam drippings have cut through the original asphalt.

All of the work involved in installing the asphalt-ballast track at South Bend was performed by company forces except the mixing of the asphalt and ballast, which was done under contract. The work was carried out under the general supervision of F. J. Jerome, then chief engineer of the New York Central System, Lines West of Buffalo. The writer was in direct charge of the work in the field.

[**621** .132 .3 (.73) & **621** .132 .8 (.73)

Norfolk & Western steam switcher has automatic controls.

(The Railway Age, July 19, 1947.)

Early in 1945 the Norfolk & Western became interested in the development of a switching locomotive which would burn coal and have a number of the advantages claimed for other types of switchers, such as high availability, flexibility, reliability and low overall operating costs.

Initially, it was determined that the locomotive should be mechanically fired to give a wide range of operating flexibility with respect to fuel available and

engine capacity. A stoker, modified from a standard locomotive unit, was selected because of its reliability and record in other services. Because of the inherent simplicity of steam-jet coal distribution in locomotive practice, this feature was to be retained in the modified stoker.

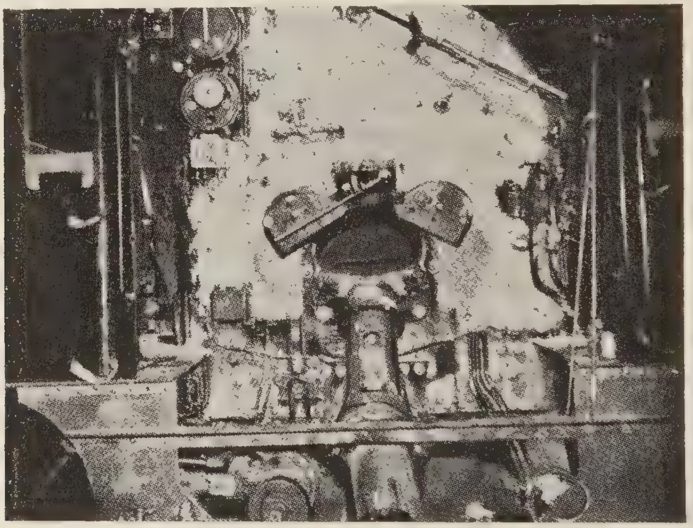
Early in the preliminary study, automatic combustion controls were given consideration because it was felt that it was desirable to minimize manual attention during stand-by service. Since one of the principal functions of combustion control is to regulate the flow of fuel in proper proportion to the air supply, a study was made of a mechanically drafted system.

A large number of experiments with mechanical draft have been conducted on locomotives both in this country and in Europe. This type of locomotive drafting had not progressed for three reasons :

First, fan operation was difficult to control by hand because of widely fluctuating loads common in locomotive practice, while no successful automatic control system had been devised to do this job.

Second, in previous experiments it had been found that either the fans were of too little capacity or that fans of adequate capacity became too large for proper installation.

Third, the abrasive nature of cinders passing through locomotive front ends caused rapid deterioration of fan blades.



Backhead, without jacket, showing the standard stoker installation and, at upper left, the Bailey Meter control panel. The feedwater pump regulator may be seen at the left of the firebox.

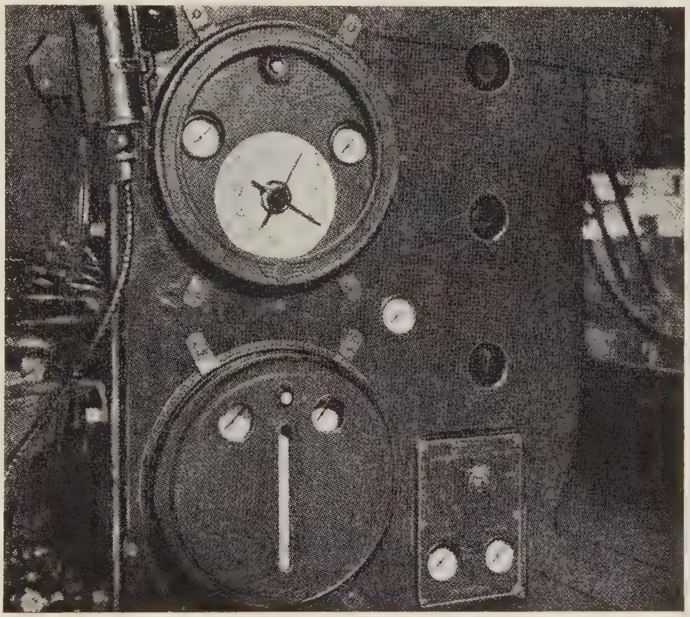
In recent years, however, successful combustion controls have been developed to a high degree of refinement and it was considered that control of the fan would not be a problem.

The art of fan design had progressed, particularly during World War II, to a point where high-speed fans of proper design were available for handling the air requirements of the proposed loco-

motive. New materials with excellent erosion-resistant qualities were also available for fan construction. It was decided that with the recent experience on induced-draft fans, the drafting of the locomotive mechanically would present no particular problem. The use of a fan was considered seriously from the beginning since a successful means of controlling draft with a conventional locomotive nozzle has not as yet been developed. Therefore, it was essential, in selecting automatic combustion controls, that a mechanical draft system be used in order to meet operating conditions.

Preliminary proposals of a locomotive with a high ratio of radiant heating surface to convection surface were made by the engineering department of the Standard Stoker Company, New York, and these proposals were studied jointly by the motive-power department of the Norfolk & Western and engineers of the Standard Stoker Company.

In the final analysis it was decided that, because of shop schedules, the first step in the experimental work would be taken by converting an existing locomotive rather than by building a new one for application of the combustion equipment. This decision made possible the study of the general arrangement and experience in converting existing switchers, of which there are a large number in service. Following this decision to convert an existing locomotive, an M2 class N. & W. locomotive, 12-wheel, 4-8-0 type, with grate area of 45 sq. ft. and 24-in. by 30-in. cylinders, was selected for the development. Following the decision by the railroad to



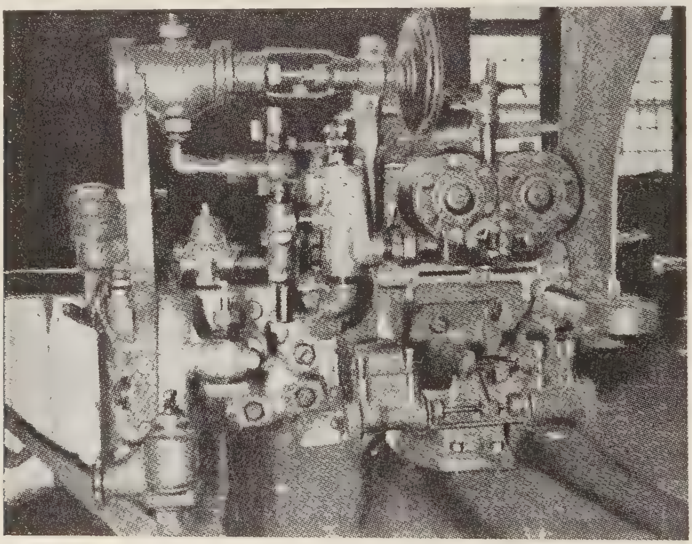
The control panel. — Upper left : hand-automatic selector valve; upper right : fuel-air ratio control; lower right : master steam pressure control.

proceed with the project, a detailed study of service requirements was made. The Bailey Meter Company, Cleveland, Ohio, was called into consulation on combustion control, and the L. J. Wing Manufacturing Company, New York 11, cooperated in the selection, design and manufacture of the draft system.

Control apparatus.

The proposed control apparatus included a controller actuated by boiler-pressure drop. Controls were to operate the fan, stoker jets and stoker. An auxiliary control system for stand-by purposes was proposed for supplying feedwater to the locomotive. Because of its simple operating characteristics, an induced-draft fan, driven by a steam turbine, was proposed. Due to the nature of switching service with respect to its influence on firing conditions, it was thought that an ashpan damper system should be included.

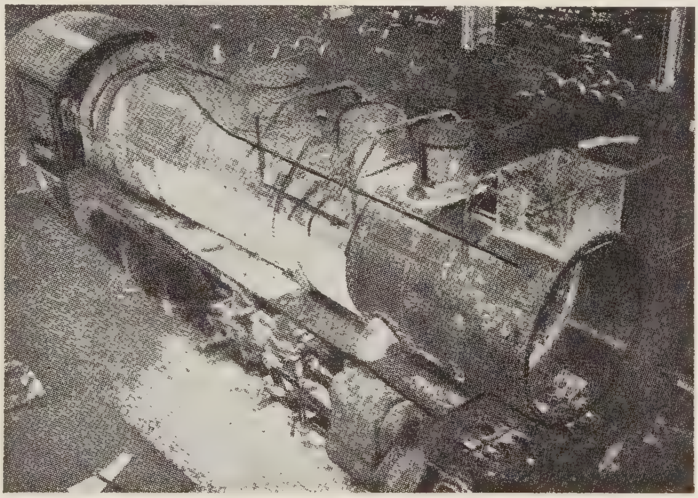
Final design features were as follows: An induced-draft fan, turbine-driven, was mounted in the front end of the locomotive. In order to install the fan it was necessary to make an extension to the locomotive front end. The design is such that the turbine and fan are installed in a separate housing as a unit which is easily accessible from the front end of the engine. Live steam is used to drive the fan since it was found that to use exhaust steam from the cylinders of the engine would complicate governing the control of the fan and would be less attractive for overall economy reasons than to use live steam directly from the boiler. Exhaust from the engine cylinders, which would normally pass through the exhaust nozzle, was relocated as a free exhaust, through a silencer. The boiler was rebuilt, with smaller flues, and a combustion chamber was installed for additional radiant heating area.



The stoker engine and diaphragm-operated control valve are at the top of this assembly. The feedwater pump and the injector are below.

The stoker was modified so that the gear ratio was extremely high to give smooth operation at very low rates. A special feed screw was designed accurately to meter the coal in relation to the air supply furnished by the fan. Ashpan dampers were installed that are to close during idle periods when the fan is not in operation.

The control equipment as installed consists of a main pressure controller for the stoker go into operation and finally the stoker is put in service. With this arrangement the air flow to the firebox always precedes stoker operation, and in this way smoke is kept at a minimum. While the functioning of the controls depends on resistance due to air flow through the grates, firebox, tubes and front end, the controls are sufficiently flexible to take care of variations in fuel bed thicknesses.



Locomotive No. 1100 during conversion at the Roanoke, Va. shop. The new smokebox, fan chamber and induced draft outlet are plainly shown.

actuated from boiler pressure. Air flow to the firebox is controlled through a special controller which is actuated from the main pressure controller. The main pressure controller also actuates the steam jets for coal distribution and the stoker itself. Control of the speed of the stoker engine is obtained through a special hydraulic tachometer connected to the engine through a V belt. While these controls operate in parallel, they are adjusted so that as the boiler pressure drops from a predetermined figure, the fan starts first, then the steam jets

During the initial stages of the development work it was considered desirable to use a cinder-collecting system on this locomotive and at the same time work is proceeding with the design of a cinder-trapping device which will entirely eliminate cinder discharge.

The experience gained so far with this locomotive indicates that the arrangement is entirely practicable and that coal-burning switching locomotives can be redesigned to incorporate an automatically controlled firing system using mechanical draft and a mechanical

stoker, with the result that locomotives now considered costly to operate could show an improved overall economy.

Some of the advantages to be gained with this type of locomotive are : much longer periods between servicing; increased engine output due to lack of back pressure on the cylinders; less attention required from enginemen, thereby increasing the work that the engine may do in a given period; and better combustion due to the regulation of fuel and air supply, thereby contributing to a reduction of smoke.

Locomotive improvements.

In the conversion of the N. & W. experimental locomotive a Standard HT stoker was installed along with Hennessy driving-box lubricators, extended mechanical lubrication, Type E Franklin radial buffer between engine and tender, overfire air jets and cinder ejectors to return the cinders collected in the front end to the firebox. The capacity of the tender was increased to 11 000 gallons of water and 20 tons of coal.

In applying the combustion chamber to the firebox, the heating surface of the boiler was changed from 4 315 to 3 215 sq. ft. as a result of shortening the flues and removing the superheater. No change was made in the firebox proper, the original brick arch being maintained. Dampers, steam-operated and automatically controlled, are used between the bottom of the mud ring and the ash pan on each side of the firebox.

General dimensions, weights and proportions of Norfolk & Western experimental switching locomotive No. 1100.

Builder	Company shops
Locomotive type	4-8-0
Road class	M-2
Road number	1 100
Date built	1910
Date converted	1947
Rated tractive force, lb., (85 per cent)	52 457
Weight in working order, lb. :	
On drivers	239 530
On front truck	40 000
Total engine	279 530
Tender (loaded)	212 000
Tender (light)	80 000
Wheel bases, ft.-in. :	
Front truck	6— 9
Drivers	16 — 0
Total engine	27— 1
Tender	27 —10½
Total engine and tender	70— 0
Total engine and tender length, over couplers, ft.-in.	81— 2¼
Driving wheels, diameter, outside tires, in.	56
Cylinders, number, diameter and stroke, in.	2—24 × 30
Valve gear, type	Walschaert
Valves, piston type, size, in.	15
Boiler data :	
Steam pressure, lb.	200
Firebox length, ft.-in.	8—4⅛
Firebox width, ft.-in.	5—4¼
Combustion chamber, length, in.	48
Smokebox diameter, outside, in.	84
Diameter, first ring, outside, in.	80
Diameter largest ring, outside, in.	91
Flues, number and diameter, in.	347—2¼
Length over tube sheets, ft.-in.	14 -6
Arch tubes, number and diameter, in.	2—3
Fuel	Bituminous
Grate area, sq. ft.	45
Heating surfaces, sq. ft. :	
Flues	2 964
Firebox and combustion chamber	251
Arch tubes (included in firebox heating surface)	10.7
Total	3 215
Superheating	none
Total evaporative	3 215
Tender :	
Type	Rectangular water bottom
Water capacity, U. S. gal.	11 000
Fuel capacity, tons	20
Trucks	Four-wheel

The application of the fan for induced draft required an extension on the end of the smoke box. The fan, furnished by the L. J. Wing Manufacturing Company, has a capacity of 37 500 cu. ft. per min. when operating at a speed of 2 600 r.p.m. The rotor of the fan has seven blades made of No. 14-gage stainless steel, and is 42 in. in diameter. The blades of the rotor of the fan, in addition to being made of stainless steel, were chrome plated with a plating approximately 0.022 in. thick to resist abrasion of cinders and fly ash. Vertical U-shaped louvers interposed between the front flue sheet and the fan remove a portion of the cinders and fly ash which are collected in the smoke box and are returned by means of steam ejectors to the firebox. The exhaust from the cylinders is discharged into the front of the smoke box on the delivery side of the fan where it is mixed with the gases of combustion and passes out the stack.

The automatic controls for the boiler were furnished by the Bailey Meter Company. An air pressure of 28 lb. per sq. in. is maintained in the control system, the air being supplied from the main reservoir on the locomotive.

The controls consist primarily of three instruments mounted on a panel on the left side of the back head of the boiler. A steam-pressure controller actuates in the proper sequence other instruments in the control system when the boiler pressure drops below the pressure for which the controller is set. A selector valve on the instrument panel permits changing from automatic to hand control. A third instrument on the panel is a ratio controller whereby the desired ratio of air supplied to the coal fired may be controlled and varied as desired. The steam-pressure controller supplies air in proportion to the demand upon the boiler to devices known as « Standatrols » which, in turn, furnish air at a somewhat higher pressure to operate diaphragm steam valves for the fan, stoker blast and stoker. By these controls the amount of air induced by the fan as draft through the firebox and the amount of coal delivered by the stoker are proportional to the demand being made upon the boiler for steam. Incorporated in the ratio controller and actuated by a differential in the draft over the fire bed and in the smoke box is a governor which maintains the correct operating speed of the fan. An oil tachometer driven off of the stoker engine automatically controls the speed of the stoker engine.

For the purpose of maintaining the desired water level in the boiler when the locomotive is left unattended in stand-by service, a duplex steam pump, furnished by the Worthington Pump & Machinery Corp., Harrison, N. J., has been installed on the left side of the locomotive under the cab. This pump, which has a capacity of 19 gallons per minute, is controlled by a thermo-hydraulic feedwater regulator mounted on the back head of the boiler.

The boiler is equipped with a low-water alarm and drop plugs in the crown sheet.

These improvements make it possible to keep the locomotive in service 24 hours a day with the exception of the time necessary to fill the lubricators, clean the fire and fill the tank with water, and the time required to re-coal the tender, approximately once every 48 hours, depending upon the service performed. The combustion has been improved with a reduction in the amount of smoke and a reduction in the cylinder back pressure resulting from eliminating the use of exhaust steam for drafting purposes. Maintaining the boiler pressure by automatic controls allows the fireman more time for observation and the safety of operation. The automatic controls further permit the locomotive to be left unattended when desired.

[**624** .63 (.44)]

Luzancy bridge, France.

(The Engineer, May 30, 1947.)

Luzancy Bridge, on the river Marne, recently rebuilt to replace a bridge destroyed during the war, is of interest as being one of the first important structures in France to be built with prestressed reinforced concrete, by a process of Monsieur Freyssinet, a former engineer of the Ponts et Chaussées.

The destroyed bridge was of the suspension type, with a central span of 55 m. (180′5 $^3/_8$″), carrying a roadway and two footways. It was blown up by French engineers in 1940 to cover the retreating armies, and was replaced in 1941 by a temporary bridge with a 16-ton load capacity.

When the construction of a permanent structure was under consideration, shortage of steel precluded a design with a steel arch of the required dimensions, which in any case would have meant rebuilding the foundations of the old bridge. It was therefore decided to build a single span concrete bridge of the type shown in the illustration. There was found to be no need to widen the old foundations in order to give a 6 m. width of roadway. Furthermore, the quantities of steel and cement required, compared with an ordinary reinforced concrete bridge designed for the same load, was nearly 50 per cent less. Three tubular concrete girders support the roadway, giving a single 55 m. span over the river. with sufficient clearance underneath for the passage of tugs and barges. The decking consists of one slab of concrete, stretching from one end of the bridge to the other, on which the concrete roadway rests. The girders are initially compressed by high-tensile steel wire reinforcement.

Luzancy Bridge, river Marne.

Each girder was made up from 22 units, each weighing 5 tons, pre-cast in vibrated concrete. Each girder, when completed, weighed 122 tons, and was erected in three sections, the two end sections each weighing 18 tons, and the central section 86 tons. Throughout the construction work, river traffic was uninterrupted. The total test load applied to the structure before it was opened for service was 244 tons, producing a deflection of 26 mm. (1 $^1/_{32}$″).

[624 .7 (.494)]

The welded bridge over the river Birs, near Bärschwil, Swiss Federal Railways,

by F. BÜHLER,

Ingénieur-Directeur de la S. A. Buss (Bâle).

(*L'Ossature métallique, July-August 1946.*)

Fig. 1. — View of the Bärschwil bridge, the simplicity of which is in complete harmony with the surrounding countryside.

The increased loads consequent upon the electrification of the Basle-Delemont line made it necessary to consider the reconstruction of the old two-span lattice girder bridge over the river Birs, near Bärschwil. The calm and peaceful aspect of this wooded valley called for a bridge with simple lines, and as inconspicuous as possible.

After very careful consideration of the matter, the choice fell on a combination design of steel and concrete, in which the flooring of reinforced concrete is rigidly connected to the main steel girders and assumes part of the load. This is the first time such a mixed system of construction has been used for a normal gauge railway bridge, in combination with continuous type main girders.

The view given above (Fig. 1) shows the satisfactory results obtained, the bridge harmonising very well with the surrounding countryside.

This result was obtained by the following factors :

a) The re-inforced concrete flooring is continuous and its depth is well proportioned with respect to that of the main girders;

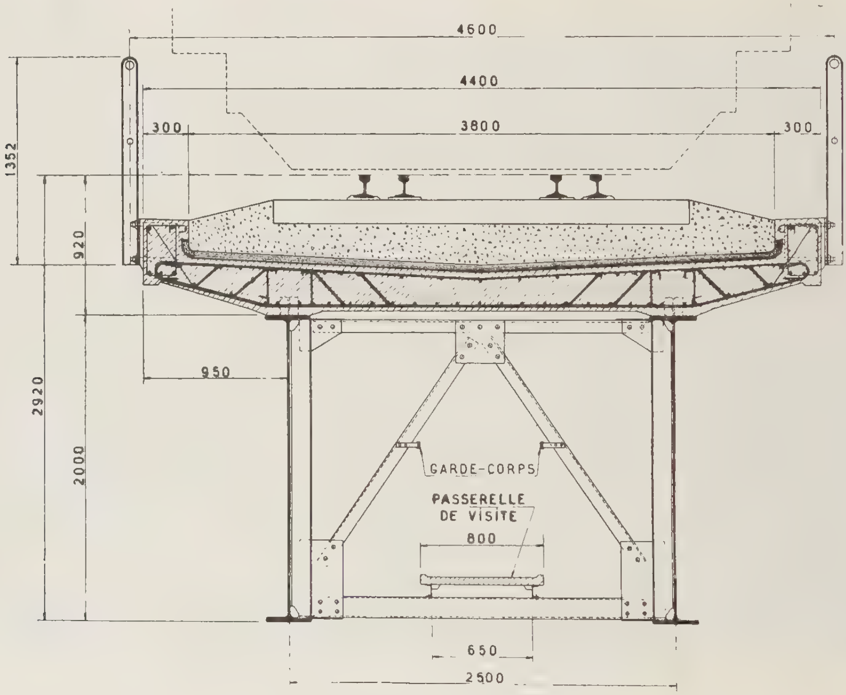


Fig. 2. — Transverse section of the Bärschwil metal railway bridge.

b) These main girders have no stiffening projections visible from the outside, save where the three supports come;

c) The central pier is of very slender form;

d) The abutments, constructed so as to be as little noticeable as possible, give to the whole a very neat and simple appearance.

The flooring, from 0.25 m. to 0.34 m. (9 27/32″ to 1′1 3/8″) thick, is of concrete mixed in vibrating mould reinforced by means of round bars of St. 37 steel. Enclosed at the sides by girders measuring 30 × 44 cm. (11 13/16″ × 1′5 5/16″) and carrying the single track laid on ballast, it is covered by an insulating layer 1 cm. (13/32″) thick and 4 cm. (1 9/16″) protecting coat having a 4.3 % slope. The width of the flooring between the handrails is 4.60 m. (15′1 1/8″) giving 1.05 m. (3′5 11/32″) overhang on each side of the main girders. The latter, two in number, 2.50 m. (8′2 7/16″), are of St. 37 steel with solid web and of a uniform height of 2 m. (6′6 3/4″); their overall length is 41.06 m. (134′8 5/8″). They are of the continuous type and rest on three supports, one of ball and socket and the others of roller pattern. These supports, parallel to the course

of the river, form an angle of about 51° with the axis of the bridge.

Constructional details.

The two main girders have been built up entirely by electric arc welding, with the exception of a fitting joint about 4 m. (13′1 1/2″) from the central pier. Each half of the bridge has seven cross-braces for the purpose of increasing its torsional resistance, six being normal to the axis of the structure, the seventh, which is located above the outermost support, being parallel to that. A system of upper and lower strengthening pieces, for resisting wind pressure, makes the whole thoroughly rigid. The support on the right bank of the river is of ball and socket type, that on the left bank has plain rollers and the one on the central pier twin rollers. This pier has been made as narrow as possible to allow the stream to flow easily at flood periods, and is surmounted by an overhanging platform carrying the roller bearings. The supports on the abutments were taken from the old bridge. A skew stay piece above the pier allows of the bridge being kept true and its level being adjusted in the event of any of the three supports suffering a change in height.

The flooring, with overhang of 0.95 m. (3′1 3/8″) with respect to the main girders, acts rigidly in association with the upper flanges of the main girders, the connection between the two being assured by a system of pin joints, proposed by the writer for the first time in 1934 and used in connection with the construction of two road bridges of 1 115 m. (3 658′1 3/4″) and 412 m. (1 351′ 8 1/2″) over the storage reservoir of the hydro-electric station at Etzel, in Switzerland. Great care has to be taken in deciding the dimensions of such items,

Fig. 3. — Main girders and flooring of the railway bridge over the river Birs.

particularly the space between the pins, as in addition to being able to transmit the longitudinal shearing efforts between the flooring and main girders, the details of such fittings must be so designed as to distribute the forces concentrated in the pins evenly over the whole flooring. With the type of concrete used and the relatively small dimensions of these pins, it becomes possible to transmit relatively high loads at such fixing points. The most satisfactory way of securing these attachments to the main girders is by welding. Moreover, the internal stresses brought about by shrinkage of the concrete must not be overlooked. For this reason the concrete used in the flooring has been formed in strips, 8.50 m. (27′10 11/16″) long. The joints between them, of dovetailed form, are strengthened by additional reinforcing pieces. This concreting was done in the middle of January and the bridge was put into service at the beginning of April 1946.

The principal problem encountered in making this connection between flooring and girders was that of preventing cracking of the former by tractive forces, especially above the central pier. Very thorough static calculations and tests were made with the object of keeping cracks, never totally avoidable, down to the absolute minimum, and as far as possible, distributed. Security against cracking depends on the shrinkage in the first instance, which must be kept at the lowest figure by the method of forming the flooring. Up to the present no crack has appeared, although the joints were closed up at the end of a week. Arrangements have been made for detecting and noting the date of appearance of the first crack, for it is of interest to determine the influence of time on shrinkage and the effect of the difference in temperature between flooring and girders.

Calculations and experiments go to show that cracks ought logically to show themselves perpendicularly to the flooring, and not near to, but at a certain distance from the girders. These considerations have been taken into account by inserting into the centre of the flooring distributing reinforcements, forming a close square framework, and intended especially as a protection against the development of cracks.

It would likewise be very desirable to undertake laboratory tests to determine the expansion taking place in high quality reinforced concrete as a function of tensional stress, especially as regards the area preceding the appearance of the first crack.

As regards the working out of the plans for the structure, the danger of cracking was taken duly into account, and for this reason particularly, the hand-rail supports were not inserted in the reinforced concrete members but were fixed thereto by bolts, this arrangement eliminating the entrance of moisture.

Building up of the welded assemblies.

The ends of the flanges were arranged to allow of assembling by lateral and frontal welding strips, of unequal length, this method having proved itself by numerous tests and examples in service.

The ribs are on the inside of the main girders, with the exception of those above the supports, the vertical ones being welded to the main members, to eliminate torsional effects from the latter.

The welding strips which are perpendicular to the tractive stresses reduce the resistance to fatigue of the girder section and call for special arrangements to counter this detrimental influence (where the vertical ribs are attached to the web). Welded construction offers the advantage of easy assembly of the skew struts above the supports. Special attention has been given to the points where the vertical and horizontal webs cross, the danger

of cracks developing there being particularly great, as well as where the vertical ribs are attached to the main members. Very great care is necessary in this matter to ensure against the possibility of failure.

The design and construction of these details constituted a difficult problem for the constructor of the bridge, the building of which was effected according to the following rules :

1. *Welding.*

a) Every welded joint must be carried out in one continuous operation, without interruption of any kind. In the case of unavoidable necessity, however, interruption is permissible provided at least six strips have been completed.

b) Transverse and longitudinal joints in X form are effected after pin-pointing, the weld points being disposed symmetrically on each side of the centre, being at a maximum distance apart of twenty times the thickness of the plates. The welding is effected at a very slow rate by two men working simultaneously from the centre outwards for the odd strips and in the opposite sense for the even strips. In case of the final strip, the piece is turned over to be welded on the other face after the rest has been faced up. After that, it is turned over at regular intervals.

c) The joint of T member is effected by a special process.

d) In sections where the stress may reach 75 % of the allowable value, the joints subjected to tractive efforts were planed off and left flush.

2. *Order of making the welds.*

a) Fixing of all parts, such as flanges and wind reinforcement gussets to the main members;

b) Assembly of the ribs and fixing of the gussets thereto;

c) Assembly of the main members;

d) Assembly of the webs.

3. *Assembling the main girders.*

a) Assembly of the T members, formed of « Grey » type half sections, to the webs;

b) Assembly of the 4 ribs to the web (by two welders working simultaneously at very slow rate, as explained above);

c) Assembly of the ribs to the main members (this calls for very careful supervision and inspection);

d) Fixing of the joint pieces to the upper flanges.

Erection on site.

The main girders were taken to the site in two pieces, 24 and 16 m. (78′9″ and 52′6″) long respectively.

Results obtained with the welded assemblies.

No smoothing out or rectifying proved necessary after the welding had been completed, either at the transversal or the longitudinal joints, none showing any deformation. As regards contraction, this scarcely exceeded 0.092 mm. (0.003619 inch) per lineal metre for the 16 m. girders and 0.08 mm. (0.00315 inch) for the 24 m. girders. These figures prove the excellent character of the methods adopted. Up to the present indeed no crack whatever has appeared in the welded joints.

Materials used.

The steel used was St. 37, the quality being checked by tests, 43 tonnes (42.3209 Engl. tons) being used altogether. The electrodes were the *Supercord* pattern, of *Oerlikon* make, especially adapted to this class of steel. No particular difficulty was encountered in the course of the work. The supporting pieces are in cast steel, total quantity used being 4 tonnes (3.9368 Engl. tons). There were 58 m³ (2 048 cu. feet) of reinforced concrete used, the reinforcements in round steel bars weighing 10.5 tonnes (10.334 Engl. tons).

[725 .31 (.73)]

What about our railroad stations? (*)

By J. C. SHERRICK.

(Railway Age, December 7, 1946.)

The recent war was one of transportation superiority. Without the superiority of the United States in transportation, in which the railroads were supreme, we surely could not have won. The war, however, accelerated developments and discoveries and has so stimulated the desire and need for travel that rail transportation is now facing one of the most challenging eras in its history. It is an era in which the supremacy of the railroads in overland passenger transportation — and perhaps also in freight — will be severely tested.

It seems apparent that the railroads cannot hope to match the speed of travel by air. It is also probable that the railroads may not be able to match the cheapness of travel by bus. But in comfort and convenience, and in carefree, and even delightful, travel, the railroads can certainly excel. The newer trains already excel in these respects and, no doubt, those now being designed will offer even more attractive features. But what about our railroad stations?

Most of our railway stations are of another era — an era when the supremacy of the railroads was unchallenged. Then, the traveler had no choice and was compelled to go to the station for his transportation needs. Similarly today, when we are summoned for jury duty or by the income tax collector, or are called to court to pay a fine for illegal parking, we are compelled to go, but we go with reluctance and find that little attention is paid to our convenience. We enter buildings which may be designed to surround officialdom with grandeur, but in which we are expected to find our bewildered way as best we can. We climb stairs; we wait in line; we depart with relief; and we do not return unless we have to. Likewise, the large railway stations of the past era were designed to enthrone the machine and impress the traveler. The traveler, duly impressed, was expected to endure some inconvenience and discomfort. The small stations of that era, built to a style attempting neither magnificence or comfort, were designed as humble servants of the machine to load passengers into trains with as little damage as possible.

In the present new and competitive era the traveler is not compelled to visit the railway stations because he has other choices of transport. The station must be made so inviting that he will be happy to enter it or else he will, with increasing frequency, choose some other way of travel, and the streamliner will lack its most important essential for successful operation — passengers. To be thus inviting, the new station must be designed not with the view to awe or impress the traveler, but to serve him. When entering the station, the traveler must be made to feel he has nothing further to worry about. From this point to his destination his way should be made easy and pleasant, and it is to modern architectural design, aided by modern methods and materials, that we must look to accomplish this highly desirable result.

(*) An abstract of an address before the recent annual convention of the American Railway Bridge and Building Association in Chicago.

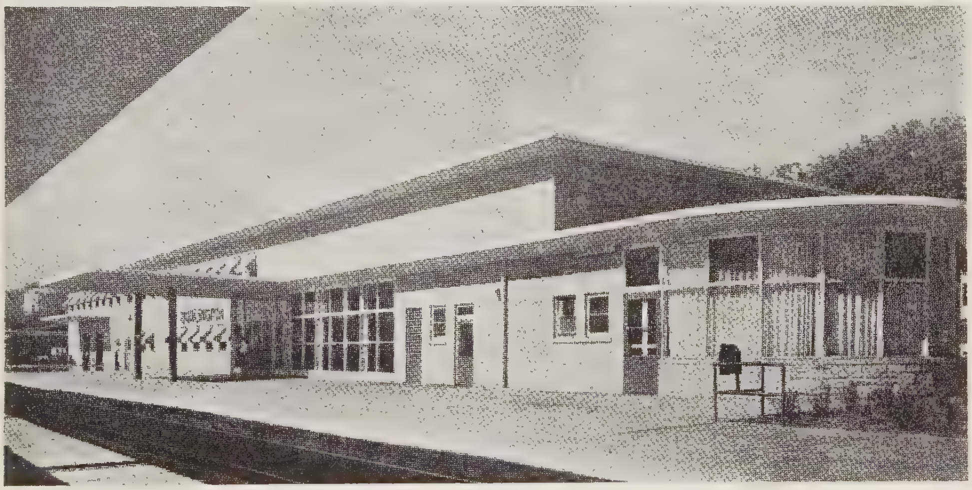
Accessibility is important.

Good architectural design will assure well-planned and easy circulation of patrons from the street to trains. The way must be made unmistakably apparent and necessitate minimum effort in buying tickets, securing information, or checking baggage. Where signs must be used as an aid to circulation, they should be designed to reassure the patron instantly as to his proper route, and should be so placed and worded as to make him feel that he is the guest of the railroad.

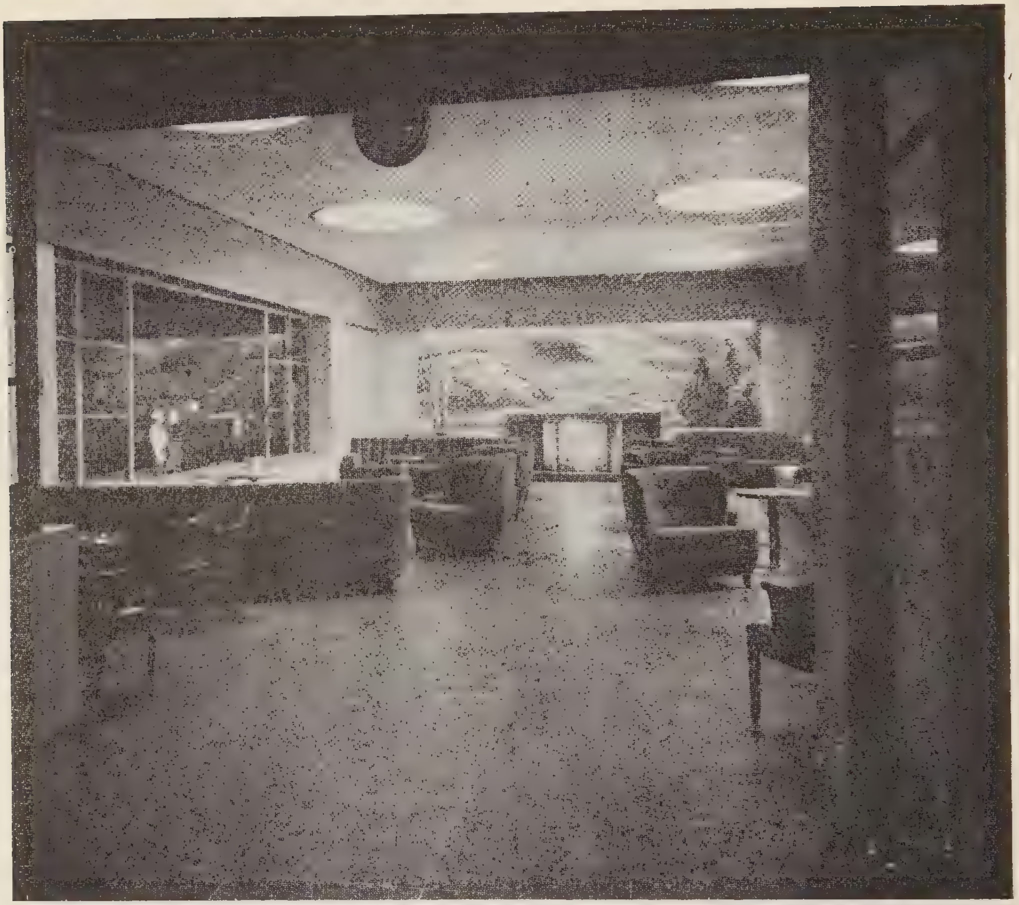
Also, good architectural design will aid considerably in making the somewhat annoying process of buying tickets more pleasant. Where tickets are purchased the railroad can demonstrate its concern for the travelers' welfare by providing features that will create an atmosphere of friendly interest and re-assuringly efficient service. Since there is nothing about the process of preparing a ticket that requires concealment, the grilled hole-in-the-wall ticket window should disappear from most stations and be replaced by an open counter. Perhaps the design can be so arranged that the railroad can relieve the traveler of his handbag at this point and deliver it to him at the train by means of conveyor systems. Such systems have been much improved by modern invention and offer real possibilities for such a service.

Interesting waiting areas.

The facilities for passengers waiting for trains must be so planned that the time spent in them will be a pleasant introduction to a delightful journey. The surroundings should be made interesting. The lighting should be planned to be an integral and important part of the architecture and must be adequate for those who care to read. The chairs must be comfortable and inviting and arranged to accommodate passengers both singly and in groups. There must be something interesting to see for those who wish to use this part of their jour-



The passenger station of today must be of an architectural style that will please the eye of the traveler, as does this Burlington station at Burlington, Iowa.



The time spent in a waiting room should be made a comfortable prelude to an interesting journey.

ney in strolling about. Here is an opportunity for planned and lively exhibits showing the advances made in railroading, to stimulate the passengers' interest, similar to the air lines' outstanding use of beautiful, illuminated maps as decorations and educational exhibits. The possibilities in the use of the radio, motion pictures, television, and recorded music should not be overlooked in plans to make the waiting period interesting to the traveler and, pursuing this thought, it is possible in large cities to make some arrangement with local art museums and public librairies for displaying exhibits of general interest.

Design embraces all features.

Refreshment places should be conveniently located but their importance as a source of revenue should not be allowed to make them discordantly conspicuous. Their place in the architec-

tural design as a whole must be studied in the planning and their decoration and character must conform and not compete with the architectural design of the station. Newsstands, too, must be planned with the architectural design so that the opportunity to examine their offerings is all a part of a pleasant experience of waiting for a train. Space for the care of infants and small children has almost become a necessity in designed as to forever erase the memory of the railroad lunch counter. A properly designed and well-conducted railroad station dining room can be a great deal more than an incidental service to the traveling public. Such a dining room can attract customers from among the non-traveling residents of a city, and such traffic offers an opportunity to publicize the pleasures of modern railway travel.

Open ticket counters aid in creating an atmosphere of friendly interest and efficient service.

many stations, and is now provided in those of a number of larger cities. In new stations such a space should be so planned that these future passengers will be introduced early to the delights of railway travel by their mothers, who will wish that their own homes offered facilities as pleasant and complete.

As to eating places, they should be so

Offices, clerical and working spaces should be designed not only to create comfortable and efficient working conditions, but also to provide flexibility in arrangement to facilitate those alterations so often made necessary by changes in processes and personnel.

All of these results will be achieved not only by careful planning and ar-

The decoration and character of refreshment places must conform and not compete with the architectural design of the station.

rangement, but also by the wise selection of available construction methods and materials. It is to be expected that the basic structural materials — concrete, steel, brick, stone, and wood — will be used for many years to come. In some cases they have proved all too permanent in the rapidly changing con-

ditions of our times. However, it is in equipment and accessories that great improvements have been made and further advances are to be expected.

Air conditioning and heating.

Air conditioning for railroad stations is surely desirable if our new stations are to match our new trains in comfort. But the feasibility of air conditioning large stations has been made uncertain by peculiar difficulties. These arise from the vast size of the spaces and from the rapid and wide variations in the density of the crowds at stations, so that to date no reasonably practicable methods have been found for the proper distribution and control of the conditioned air. But new development give some promise for the solution of the problem. New air-handling systems carry air through ducts at velocities of 4 400 ft. per min., which is more than four times the velocity formerly considered the maximum. One new distribution system has an air velocity at the outlet nozzle of 12 000 ft. per min., making possible the distribution of air over a distance of about 240 ft. These developments mean that duct systems can be smaller and simpler, and outlets farther removed from the areas served. Work is being done on refinements in control system. We can even hope that the perfection of these various elements will make possible a reasonable system for air conditioning existing stations without too much alteration.

Panel, or radiant heating, is not precisely a new system because it was used by the Romans. But its modern developments have a special interest for designers of railway buildings. The huge waiting room of the Cincinnati Union Terminal, planned by Felheimer and Wagner, architects, is warmed by an application of the principle of panel heating. The roof and extensive glass areas of this room are double and warm air is circulated within the double construction, maintaining a comfortable temperature in this vast room without a single radiator. Panel heating provides comfort at comparatively low air temperatures and its claimed ability to maintain fairly uniform, comfortable conditions in drafty spaces where cold outside air is frequently admitted, makes it worth considering when selecting a heating system for stations or service buildings.

There are marked improvements in the design and variety of portable partitions, some of which are very attractive in appearance. In office spaces which are designed with level floors and flush ceilings throughout, they permit the quick and easy rearrangement of space without the fuss and dirt which usually attends such alterations.

In lighting, we are all much interested in the development of the gaseous tube, which is especially well adapted for incorporation as an integral part of architectural effects. Its low current consumption, low heat output and long life are also advantages not to be overlooked. It is at its best efficiency when fairly close to the object or space to be illuminated.

Double and multiple glazing, long used in the construction of railway cars, is available in several convenient forms of units. When combined with improved heat-resisting glass, it is a valuable aid in relieving the heat load in air-conditioned spaces and in maintaining comfort in other spaces. It may prove interesting in the construction of signal towers as well as other buildings.

Spirit of today is inquiring.

These are but a few of the more familiar and proved systems and materials. These and many other developments, as they become available and prove themselves worthy, will be incor-

porated in new railway buildings, but it is only through the artistry of modern architecture that they will become integrated in the design to give expression to the new spirit with which the railroads must meet the new era.

Every architectural style has been modern in its day and has accurately reflected the spirit of its age. Since the spirit of today is an inquiring one, which is exploring new forms of energy, questioning established traditions, seeking new forms of social organization. and discarding old forms of trains for new and exciting designs, modern architecture will also explore and develop new and exciting ideas for passenger stations, so that the traveler of today, or certainly of an early tomorrow, will conciously, or instinctively, appreciate and approve those ideas as a true expression of his own spirit.

NEW BOOKS AND PUBLICATIONS.

[**656** (.493)]

MINISTERE DES COMMUNICATIONS (Belgique). — MINISTRY OF COMMUNICATIONS (Belgium). **Les Transports en Belgique depuis la libération** *(Transport in Belgium since the liberation).* — Report of the « Office National Régulateur des Transports ». — One volume ($8\frac{3}{4}$" × $11\frac{3}{4}$") of 150 pages, copiously illustrated, maps. 1946. — Brussels : Anciens Etablissements d'Imprimerie Th. Dewarichet, 16, rue du Bois-Sauvage.

In 1946 the Ministry of Communications published in book form a report from the Transport Regulating Office dealing with transport in Belgium since the liberation.

This book was conceived on the following plan : division of the work into 5 chapters, the first four each starting with a brief general survey summing up broadly the matter then dealt with in detail, well classified and copiously illustrated with photographs, maps, diagrams and statistics.

The final chapter is devoted to general conclusions, the co-ordination of transport and plans for the future.

The book is completed by detailed statistics.

We give below a brief analysis of the different chapters.

Chapter I.

This chapter deals with the transport position at the time of liberation, the damage suffered and the initial work of reconstructions.

Serious damage and great destruction due to heavy aerial bombardment and many acts of sabotage was suffered by the railways, waterways, and to a lesser extent road communications during the course of 1944, involving a considerable reduction in the transport capacity of the country in each of these three spheres.

It was however essential to assure not only the transport necessary for the national economy of the country, the transport of agricultural products and foodstuffs, raw materials and finished goods, but above all the important military traffic of the campaining armies which had to pass through the country with the assistance of allied transport corps.

As the author of the report puts it :

« The sum total of this devastation necessitated energetic and immediate action. Restoration programmes were drawn up without delay and the work commenced at once by every possible means. The country cannot overestimate the enormous debt it owes to all those who worked to this end, particularly the staff of the railways, bridges and highways. »

Details of the damage and loss of transport material, and the initial results of the steps taken to remedy them are dealt with separately for the Belgian National Railways, the Light Railways, waterways and road communications.

For example in the case of the Belgian National Railways, the report covers the permanent way and works, signalling installations, motive power, telecommunications, stations and buildings, the matter being presented very clearly and methodically, supported by diagrams, maps and photographs.

It may be mentioned that in the case of the waterways, a paragraph is devoted to the work of bringing these up to date and improving them.

Chapter II.

This chapter deals with transport from the liberation up to the end of 1944.

Military transport enjoyed absolute priority on the railway lines brought back into operation.

Structural damage made it impossible for water transport to be restored as quickly as rail transport.

The light railways and roads were limited to regional traffic or even local traffic in order to carry out the most useful work.

The National Transport Regulating Office was set up on the 27th November 1944 with the object of overcoming any weakness likely to delay the return to normal, taking part in investigations to improve the operating and re-equipment, suggesting the quickest and most effective solutions, and co-ordinating the efforts and actions of the different methods of transport.

Statistics and graphs give a clear picture of the results obtained.

Chapter III.

Transport during the year 1945.

During 1945, thanks to progressive improvements in the operating, the transport capacity of the railways and waterways increased to a considerable extent.

The end of hostilities contributed to a great extent in putting an end to the difficulties reported in the previous chapter, due above all to a great shortage of wagons.

The report shows clearly how traffic picked up : the coal traffic, seasonal traffic, international traffic, the activity of the ports of Antwerp and Ghent; and the steps taken to meet the problems that arose.

Chapter IV.

Transport during the first quarter of 1946.

From the beginning of 1946 it was clear that the transport facilities available in the country could meet with ease all the demands of industry and commerce.

The outstanding facts of this first quarter of 1946 are reviewed; the signs of lively competition between the railways, waterways and road transport became more and more marked; on the 1st April 1946 important steps were taken simultaneously as regards railway rates and river freight charges.

Everything is ready to assist as required in a new expansion of the economic life of the country.

General Conclusions.

Amongst these conclusions, it seems advisable to stress the paragraph relating to the co-ordination of transport, which is a very pressing problem in a great many countries.

We will quote in full the three main principles on which the method suggested by the Government organisation is based :

a) The policy of co-ordination must be souple in order to be readily adaptable to any evolution in the general economic situation with which it must be at all times in equilibrium.

b) If any co-ordination is to be achieved, this postulates that the State must be able to control the actions of the three methods of transport without intervening in their internal affairs. Railway, road and water must each keep their own personality and the public authorities can only act upon them through the intermediary of specialist organisations. Without such a possibility, and if consequently one section of transport remains entirely free in its

development, apart from any State enterprise, such a section could at any given moment develop in such a way as to destroy the equilibrium aimed at by co-ordination.

c) Finally co-ordination can only result in useful and equitable results in so far as it is based on undoubted facts, and these depend on the systematic consultation of all those interested. Care must therefore be taken to determine the most adequate method of consultation.

As regards the future, mention may be made of the electrification of the railway in particular, which is being carefully investigated by the National Railway Electrification Commission on the basis of the traffic expected and the income therefrom. Such large scale work would enable the electric rolling stock manufacturers to perfect their equipment and working methods, so that they would be in a position to compete with other countries in the export markets, to the benefit of our own workmen.

The above is a brief review of the 1946 Report of the National Office for the Regulation of Transport.

J. D.

[**621** .132 .3 (.4) & **621** .132 .5 (.4)]

The « Liberation » locomotive — 2-8-0 type with double bogie tender for European use. — A pamphlet ($8\frac{1}{4}'' \times 11\frac{1}{4}''$) of 8 pages and a table. — 1946, *The Railway Gazette*, 33, Tothill Street, Westminster, S.W.1. (Price 2*s*./—.)

This pamphlet is a reprint from *The Railway Gazette* of the 28th June 1946 of an article describing in detail, with many diagrams and photographs the « Liberation » locomotive built by the « Vulcan Foundry Litd. ».

Hundred and twenty of these locomotives are being built for Poland, Czechoslovakia, Jugoslavia and Luxemburg.

The project was originally due to the Technical Advisory Committee of Internal Transport (T.A.C.I.T.) composed of delegates of the British and Allied Governments which met in London during the war to prepare the way for the reorganisation of transport on the Continent of Europe as soon as the reconstruction of Europe became possible.

This Committee asked the Ministry of Supply to examine its proposals and make the necessary plans. The « Vulcan Foundry » in the name of the Association of Locomotive Builders was given the task of designing this locomotive.

The locomotive had to be more powerful than the 2-8-0 « Austerity » locomotive then under construction on behalf of the War Ministry, and suitable for general use on standard gauge European Railways.

The specifications and preliminary drawings were soon prepared and submitted to the Committee which included representatives of France, Belgium, Holland, Czechoslovakia, Poland, Jugoslavia and Greece. After a few slight modifications had been made, these specifications were quickly approved and plans put in hand to carry out the work at the end of 1944.

The leading dimensions of the « Liberation » locomotive as given in the pamphlet are briefly given below :

	Metric.	English.
Cylinders (two), dia. × stroke	550 mm. × 710 mm.	21 5/8 in. × 28 in.
Coupled wheels, dia.	1 450 mm.	4 ft. 9 1/8 in.
Pony truck wheels, dia.	850 mm.	2 ft. 9 1/2 in.
Wheel-base, coupled	4 950 mm.	16 ft. 3 in.
Wheel-base, total engine	7 660 mm.	25 ft. 1 3/4 in.
Working pressure	16 kgr. per sq. cm.	227 lb. per sq. in.
Heating surface :		
Tubes and flues	194.33 sq. m.	2 098 sq ft.
Firebox	16.26 sq. m.	175 sq. ft.
Total evaporative	210.59 sq. m.	2 273 sq. ft.
Superheater	61.30 sq. m.	660 sq. ft.
Combined total	271.89 sq. m.	2 933 sq. ft.
Grate area	4.09 sq. m.	44 sq. ft.
Tractive effort at 85 per cent. boiler pressure	19 900 kgr.	43 800 lb.
Adhesive weight	74.75 tonnes	73.55 tons
Factor of adhesion	3.76	3.76
Weight of engine in working order	85.674 tonnes	84.3 tons
Weight of tender in working order	59.105 tonnes	58.2 tons
Weight of engine and tender in working order	144.779 tonnes	142.5 tons
Water capacity of tender	25 cu. m.	5 500 gal.
Coal capacity of tender	10 200 kgr.	10 tons

E. M.

[385. (09 (.42)]

The London Midland & Scottish Railway Company. — A record of large-scale organisation and management, 1923-1946. A brochure (5¾" × 8¾") of 20 pages with numerous tables. Published by the L.M.S.R.

The L.M.S. Railway was formed 23 years ago by the amalgamation of 35 different companies. The new Company then became the largest commercial undertaking in the country, a position it still holds. An enormous task lay before those who had to mould all these parts into a single cohesive whole and lay down the principles and proper methods for creating an effective method of public transport.

From the beginning it became apparent that 10 to 20 years would be required to see these efforts crowned with success, so that many of those involved could not hope to see their proposals arrive at maturity. Their task was to lay a true and sure foundation for future developments.

Now that many changes appear imminent and the problems to be solved require all the skill and experience of railway men, it seemed to the Management of the L.M.S. to be a propitious time to review the methods applied and the results obtained, so that a report

thereon might be of value to those who would complete the work that had been begun.

The review covers all the departments concerned in the operation of a very large railway system, and in each case stresses both the organisation and unification measures that have been taken, as well as new technical applications and the steps taken to improve the efficiency of the services.

The first task was the formation of the administration and management. From the operating point of view, the system was composed of four divisions. In the case of the Central Administration in London, after a few years the executive powers were placed in the hands of a president and three vice-presidents, each of whom acted as the general manager of a given series of departments, the heads of which came under his orders. Sub-committees were formed to deal with such matter as : finances, traffic, rolling stock, way and works, legislation, staff, navigation, etc.

The permanent way was progressively improved in order to make it suitable for the considerably increased loads and speeds. Brief mention may be made of the increase in the weight of rails, trying out a new method of impregnating the sleepers, trials of rails with flat inside faces, extended use of transition curves, the use of welding, crossings at two levels, improvements in the construction and maintenance of structures.

In the case of the signalling, yellow lights and colour plates replaced red on the signals in order to make them more easily seen from a distance. Widespread use has been made of track circuits. Electric signal boxes have replaced many mechanical signal boxes. Distance control of points has been installed. Intermediate block signals with coloured lights worked from neighbouring signal boxes have made it possible to decrease the number of boxes or deal with heavier traffic.

The telecommunication system has been improved by creed teleprinter circuits. Thousands of miles of new telephone lines have been laid, and use has also been made of existing telephone circuits.

The stock of locomotives has been standardised to reduce the number of different types, and new types have been designed very carefully in order to obtain safe working, a power suited to the load, and low consumption. The average daily mileage increased by 30 % between 1923 and 1938. This result was obtained on the one hand by perfecting the routing of the staff, and on the other by decreasing the time spent in the shops. In the latter, the working methods have been thoroughly modernised.

The new passenger coaches are all metal and various improvements have been made to increase the comfort. Here again the new methods used in the shops have made it possible to save a lot of time, reduced the cost of repairs and construction, and increased the production capacity.

In addition to its railway rolling stock, the Company owns 10 000 road motor vehicles. The maintenance of this important stock is covered by a vast organisation, which is responsible for overhauls based on two factors : the mileage and the time in service. This has made it possible to reduce both the time taken for repairs and their cost.

As regards the stores, the first task was to standardise the methods. A special section was charged with specifications and formulae for tenders. Standardisation has made it possible to reduce the number of printed formulae from 3 300 to 800. The Company set up a Scientific Research Department, the activities of which are controlled by a Research Committee set up by the Council and assisted by a consulting committee formed of scientists. Thanks to its composition and its contacts with

Government Research Stations, as well as the exchange of documents and staff with teaching establishments, this Department has become invaluable for all investigations.

The working of the traffic and the commercial methods employed are the subject of two very important chapters, which it is impossible to analyse or sum up in a few lines. Mention is made of the considerable progress achieved in speeding up the passenger train services and in the reduction of delays in goods transport. The latter chapter deals with the methods used to get or keep traffic and co-ordination with other methods of transport.

The administration of a staff which consists of a quarter of a million of employees is in the hands of a central organisation. The regulations make provision for discussion and the solution of all question which may arise, both those affecting only a few members of the staff and those of general interest. Special attention has been given to the mechanisation of clerical and office work.

In this brief note we have only been able to make mention of the most striking facts, leaving on one side many interesting applications and improvements. We have not even mentioned several chapters, such as those dealing with the facilities available to passengers in the stations (the L.M.S. is the largest hotel manager in Europe). Nevertheless, the reader will, we hope, have got some idea of the value of this book, and the size of the work of organisation and modernisation accomplished by the Company during its first twenty-three years.

E. M.

[**656** .254 (.73)]

ASSOCIATION OF AMERICAN RAILROADS (A. A. R.), Signal Section. — **American Railway Signaling Principles and Practices.** — *Chapter IV* : **Centralized traffic control.** — A brochure (6″ × 9″), illustrated. — Published by the Signal Section of the Association of American Railroads, 30, Vesey Street, New York, N. Y. — Price : $ 1.25, reduced to $ 1.00 for the members of the A. A. R. and railwaymen.

The Signal Section, which is a part of the larger body known as the Association of American Railroads (A.A.R.) and counts amongst its members the leading authorities on the subject of signalling, has issued in similar form a considerable number of papers relating to signalling installations and equipment. We have given short accounts of these from time to time.

Chapter IV is entitled « Centralised Traffic Control ». According to the definition given by its authors, this means a method of working which allows of the train movements over the various routes and through the various block sections on a given length of line being directed from some selected point, without having recourse to train orders, or what is called in America the superiority of trains. The abolition of train orders makes it necessary to instal special signals, which indicate to a train when it is required to stop and obtain instructions from the train dispatcher.

This method of working is no longer novel in North America, its first application having taken place in 1927 when it was put into service on a 40.2 mile route with a 36.9 mile section of single line route on the New York Central Railroad. Statistics published by the Interstate Commerce Commission on January 1st 1939 showed that there were by

then 180 installations in service covering 1 594.3 route miles of railways, or 2 051 track miles altogether.

As will be realised, the apparatus used has been the subject of various improvements, as the number of installations has increased. The first equipment used was of the « non-coded » type, requiring the use of a separate wire to each function operated and a common return. Later « coded » apparatus was developed, using trains of relatively short impulses in order to transmit over a limited number of line wires the operating and indicating signals between the controlling office and the appliances out on the line.

At the dispatcher's office the movement of the trains was followed at first by means of cards or tickets, which the operator himself moved from place to place on the apparatus, but now it is marked down automatically as a graph on a chart which moves forward at a constant speed.

The present work gives a very detailed description of the equipment, explaining the entire sequence of operations with the aid of very complete circuit diagrams, some in the text, the others on folding plates.

The development of C.T.C. and its applications has been due more particularly to two American firms, the General Electric Company and the Union Switch and Signal Company, the latter having produced more recently the so-called « time-code » equipment, in which the line current impulses are at different lengths, long or short.

The longest length of railway worked in this manner covers 105 miles, and the longest distance between the dispatcher's office and the furthest outside function controlled by it is 94 miles.

No doubt it may be held that methods and equipment of this kind are primarily suited to a combination of special circumstances such as absence of local traffic and long lengths of single line, but the fact that they have been developed and been applied on a large scale (36 American railways now use them) makes them of very great interest.

This Chapter IV is a noteworthy example of the care with which the publications of the Signal Section of the A.A.R. are edited and produced and is of the highest technical value.

E. M.

[**385**. (09 (.492)]

De IJzeren Weg. — Holland bouwt op *(The Railway. — Reconstruction in Netherlands)*. — A brochure ($5\frac{1}{2}'' \times 8\frac{1}{4}''$) of 44 pages, copiously illustrated. — 1947, Utrecht, « Het Hollandsche Uitgevershuis », Publishers.

This pamphlet of 44 pages, illustrated by many photographs, is a tribute to the attitude of the Dutch railwaymen during the war and their help in the reconstruction of the railway.

In a short introduction Dr. Ir. W. Hupkes recalls the difficult years when they were working under German occupation, the strike from the 17th September 1944 until the liberation, the destruction caused by the enemy, and the rapidity with which reconstruction took place in spite of innumerable difficulties. He also describes briefly the future programme of the Dutch railways.

A striking chapter is devoted to a report of the destruction caused by the Germans, which describes the pitiable condition of the railway when the serv-

ices were resumed and the results obtained by these reconstruction efforts by October 1946.

Here are some of the figures :

Permanent way. Out of the 3 159 km. (1 963 miles) of line in September 1944, 1 954 km. (1 214 miles) or 62 % was stolen or destroyed. In October 1946, 3 007 km. (1 868 miles) were in service again.

Locomotives. Out of 866 locomotives, the enemy destroyed or carried away 722, i.e. 84 %. By October 1946 there were 753 usable locomotives.

Carriages. 1 406 out of 1 500 were stolen or destroyed. In October 1946, 444 Dutch coaches and 308 coaches from abroad were in service.

Wagons. Out of 29 616, 29 156 were stolen. In October 1946, there were 12 009 in service.

The destruction of bridges, buildings and shops was on a similar scale.

The total damage suffered is estimated at 500 million florins.

An eyewitness recounts how in spite of a thousand obstacles the Tilbourg shop staff resumed work as soon as the town was liberated on the 27th October 1944.

One chapter is devoted to the railway strike called by the Dutch Government on the approach of the allied armies. We are told of the tribulations caused to the staff by this strike, how they were tracked down by the Germans, and the ravages caused by the stopping of the whole economic life of the country and by famine.

We recognise the sacrificial spirit of the railwaymen who having valiantly begun the strike had to suffer in patience the most grievous physical and moral trials for seven long months.

Finally the pamphlet describes the plans for the future, electrification, increasing the speed of both goods and passenger trains, and the construction of metropolitan railways in the important cities of the West : Amsterdam, The Hague and Rotterdam.

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PUBLISHED UNDER THE SUPERVISION OF

P. GHILAIN,

General Secretary of the Permanent Commission of the International Railway Congress Association.

(OCTOBER 1947)

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KOLLBRUNNER (F.) et WICHSER (O.). — **ponts en auge** de Vedeggio et du Trodoback (Su
(2 600 mots & fig.)

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TROLLUX (J.). — Les **locomotives BB 0401**
S. N. C. F. (4 000 mots & fig.)

1947 **385 .517 .6**
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Dr LE GO & TELLIER. — **Equipage radiologiqu**
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MAUZIN. — Utilisation des **appareils à quartz**
électriques pour aider au relevage du pont Mora
Lyon. (2 000 mots, tableau & fig.)

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CHAVANE DE DALMASSY & LOZÉ. — **Destruc**
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MOUSSET. — La **nouvelle tarification des marc**
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phiques.)

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MARTIN (R.) & CAUCHOIS. — Le **poste « électro-canique »** de Paris-Nord. (4 000 mots & fig.)

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La circulation des hommes et des marchandises. (Conence de M. DAUTRY.) (4 800 mots.)

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946 624 .2 (.73)
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eport of Committee 16. — **Economics of railway loca- and operation.** (Economics of railway operation. ck capacity and train performance.) (6 500 words, es & diagrams.)

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1946 621 .133 .7 (.73)
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Report of Committee 13. — **Water service and sanitation.** Relative effectiveness of cathodic protection and painting in preventing corrosion of the interior of steel tanks. (1 600 words & fig.)

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Report of Committee 14. — **Yards and terminals.** Locomotive terminals. (6 000 words.)

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Report of Committee 1. — **Roadway and ballast.** (Second progress report of the investigation of methods of roadbed stabilization.) (20 000 words, tables & fig.)

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1947 625 .285
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Metallurgical topics. — **Continuous casting.** (2 000 words & fig.)

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The Engineer, No. 4771, July 4, p. 10.
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1947 **656 .222 .1 (.42)**

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1943 **625 .154 (.42)**

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BRADBURY (W. P.). — **Refrigerated transport by rail.** (2 200 words & fig.)

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Modern breakdown crane practice. (1 200 words &

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EACHAM (T. E.). — **High-pressure gear pump.** 000 words & fig.)

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LLIS (G.). — **Stress determination by brittle coat-** (3 000 words & fig.)

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17 656 .212 .8
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ULTNEY (E. C.). — Landmarks of **express loco-e progress.** The coming of the big engine. Parts I-II e continued). 1 800 words & fig.)

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« **Southern's** » **Diesel express locomotive programme.** (300 words & fig).

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TREACHER (D. C.). — **Blanketing of track.** (3 500 words & fig.)

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BEST (W. H.). — **Authorised relaying on the L. M. S. Railway.** (4 000 words & fig.).

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S. P.'s all-steel bay-window **cabooses.** (600 words & fig.)

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Long-compression poppet valves increase low-speed tractive force. (500 words & fig.)

1947 **621 .132 .5 (.73)**
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Norfolk & Western steam switcher has automatic controls. (2 000 words & fig.)

1947 **656 .225 (.73)**
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C. N. R. freight loss with new weapons. (1 000 words & fig.)

1947 **625 .28 (.73)**
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General Motors « Train of Tomorrow » is on exhibition tour. (2 400 words & fig.)

1947 625 .234 (.73)
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Test installation of vapor car's new rador heating system. (600 words).

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New York Central rebuilds engine-house at busy Englewood terminal. (800 words & fig.)

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LEAF (W.). — **Removing silica from boiler water.** (1 400 words & fig.)

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Milwaukee uses **tie-spacing template.** (1 800 words & fig.)

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Plastic interior for a **standard passenger railway coach.** (1 200 words & fig.)

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Milan to Domodossola electrification. (600 words &

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Electric traction progress in Sweden. (1 600 w
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The **new railway** to Greenford. (2 400 words &

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Long welded rails in the U.S.A. (1 000 words & tal

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LING (H. H.). — **Railways in China.** Capital requ
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Reconstructed Pullman cars for the « Devon Bel
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New Danish State Railways Ferry. (600 words &

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ALLEN (C. J.). — **British locomotive practic performance.** (2 500 words & tables.)

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ANSON (A. J.). — **Power for passenger cars.** (2 300 ds & fig.)

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ILLIAMSON (R. A.). — **Great Northern single-cab 0 H.P. electric locomotive.** (1 400 words & fig.)

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RICH (K. L.). — **Engineering a railroad shop.** (2 400 ls & fig.)

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44 62 (01
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44 625 .143 .3
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4 625 .143 .3
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1944 625 .143 .4
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Second progress report of the investigation of fatigue failures in rail joint bars. (12 pages, tables & fig.)

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WALKER (H. L.). — **Principles of heat** treating steel. (45 pages & fig.)

1944 624 .2
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LOONEY (C. T. G.). — **Impact on railway bridges.** (125 pages, tables & fig.)

1945 625 .143 .3 & 625 .143 .4
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ALLEMAN (N. J.). — **The effect of the ratio of wheel diameter to wheel load on extent of rail damage.** (19 pages, tables & fig.)

In Danish. (= 439.81.)

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ENGQVIST (Th.). — **The Danish State Railways 1847-27th June 1947.** (500 words.)

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THORNING CHRISTENSEN (Sv.). — **The construction and rolling stock** of the Danish State Railways during a century. (1 500 words & fig.)

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1947 656 .211 .7 (.489) = 439 .81
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PRINDSHOLM (M.). — The **sea-routes** of the Danish State Railways. (1 500 words & fig.)

1947 624 (.489) = 439 .81
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1947 **656 .25 (.489) = 439 .81**
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GØTZSCHE (O.). — **Safeguard of telephone, telegraph and radio installations** on the Danish State Railways. (2 800 words & fig.)

1947 **656 .222 .4 (.489) = 439 .81**
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1947 **656 .224 (.489) = 439 .81**
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THORNING CHRISTENSEN (Sv.). — Copenhagen, its **suburban traffic** and the Danish State Railways. (1 550 words & fig.)

1947 **385 (.489) = 439 .81**
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NIELSEN (Fr.). — **Reconstruction of the Railway bridge** over the river « Storaaen », near Holstebro, of the Vejle-Holstebro line. Lateral stability of the secondary girders. (1 300 words & fig.)

In Italian.

Ingegneria ferroviaria. (Roma.)

1947 656 .222 .1
Ingegneria ferroviaria, aprile, p. 139.
KRALL (G.). — **Velocità critiche nelle costruzioni ferroviarie.** (5 000 parole.)

1947 625 .151
Ingegneria ferroviaria, aprile, p. 145.
ROBERT (G.) & PIZZOLI (A.). — Progetto di un **corredo di scambi** per ferrovia principale. (4 000 parole & fig.)

1947 625 .214
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CONTI (G.). — Le **boccole a rulli** nei vecchi e nei nuovi rotabili delle F. S. (2 200 parole & fig.)

1947 621 .332
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BELLANTE (E.). — **Esperienze aerodinamiche su catene di isolatori.** (6 000 parole & fig.)

1947 625 .144 .2
Ingegneria ferroviaria, maggio, p. 187.
BALATRONI (F.). — Considerazioni sulla **sopraelevazione della rotaia esterna** e sul suo raccordo. (3 600 parole & tavole.)

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FERRETTI (P.). — **Turbine a combustione int**
con Diesel-boiler. (2 500 parole & fig.)

1947 **625 .143**
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BALDACCI (R. F.). — Influenza dello sforzo di ta
nello stato di **sollecitazione dinamica di una rot**
(2 000 parole, tavole & fig.)

1947 **625 .1 (.44 + .45 + .4**
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QUAGLIA (A.). — Le **comunicazioni transalpine**
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Il **primo centenario delle Ferrovie Svizzere.** (3
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1947 **621 .335 (.4**
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MASINO (G.). — **Nuovi elettrotreni svizzeri** a
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LEVI (F.). — **Calcolo delle strutture** compost
elementi in stato di coazione e di elementi allo s
naturale non deformato. (1 000 parole & fig.)

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AMMENDOLA (L.). — La configurazione delle
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In Dutch.

Spoor- en Tramwegen. (Utrecht.)

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